AMERICAN MACHINIST

October 15, 1941

Choose Your Steel—*Unless you have an A1A priority you may have to forego some of the alloys formerly used. It's time to look for available alternates*

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TO USE THIS ISSUE

IF YOU'RE GOING TO THE SHOW:

1. Read through the Show-in-Print section in detail, checking those items which you want to see and noting any questions in margins.
2. Check booths you intend to visit in the List of Exhibitors.
3. Use this issue as a preview and guide to the Show.

IF YOU'RE NOT GOING TO THE SHOW:

1. Look through the Show-in-Print—there may be so many items you want to know more about that you'll decide to go.
2. Check advertising pages for further detail.
3. Keep the issue as your permanent record of the Show.

IN EITHER CASE:

1. Read the special section on "Alternates for Priority Materials"—then mark it for filing.
2. Note carefully the record of new heat-treating and welding processes. Can you adopt—or adapt—any of the ideas pictured?
3. Preserve the issue as a working handbook—showing methods in the editorial pages, equipment and supplies in advertising pages.

THE ANNUAL METAL SHOW NUMBER of AMERICAN MACHINIST

WHAT'S IN THIS ISSUE

American Society for Metals | *American Welding Society*

OSCAR E. HARDER

BRADLEY STOUGHTON

COL. G. F. JENKS

K. L. HANSEN

A.S.M.—A.W.S. OFFICERS

The National Metal Congress & Exposition is in Philadelphia this year, October 20–24, at Convention Hall and the Commercial Museum. It is a combined effort by the American Society for Metals and the American Welding Society. We present on this page several officers of those societies: Oscar H. Harder, Batelle Memorial Institute, has served for the past year as president of A.S.M., and will be succeeded this year by Bradley Stoughton, Chief, Heat-Treating Equipment Unit, Tools Section, Office of Production Management. Col. G. F. Jenks, Ordnance Department, U. S. Army, and K. L. Hansen, Consulting Electrical Engineer, Harnischfeger Corporation, have been re-elected president and first vice-president, respectively, of A.W.S.

PRIORITY STEELS

Many steel consumers are staying up nights trying to figure out what available steels they can use for specified jobs in place of alloy steels under strict rationing. Today priority regulations apply to all types of alloy steels. It is a real problem to choose the right steel for the right job when the job happens to be non-defense work or is far down on the defense priority list. To help you make that choice we are presenting in this issue (page 1039) another of our famous "Blue Sections." Not only are priority restrictions on steels discussed, but also alternate steels are suggested to replace those hard to get. The job of putting this section together represented a major effort by one of our able associate editors, William J. (Bill) Hargest, aided and abetted by experts inside the steel industry itself. This section is so timely that you will want to have it on your desk for constant reference if you are a steel user faced by the problem of employing steels other than those to which you are accustomed.

MECHANIZED FURNACES

There are probably hundreds of different types of heat-treating furnaces for production purposes. It's no small job to select the right one for specific requirements. To aid you in this problem, we present on page 1027 the first of a series of articles on the subject. The furnaces are treated as machines from the standpoint of advantages and disadvantages, work-handling methods, work speeds and loadings, and fields of application by material and process.

ARMAMENT

A Canadian plant changed over to the production of 75-mm. cartridge cases from 3.45-in. cases. Production soon reached 600 cases per hour, which should interest U. S. plants. We give you tooling details on this job as well as important data on annealing between draws. The second feature of our Armament Section tells you how parts for airplane ribs are standardized, permitting the design of special machines to roll, form, punch and rivet the parts on a production basis.

SHOW IN PRINT

Beginning on page 1014 we present a preview of all *new* equipment on display at the Metal Show. You'll find illustrations of new furnaces, furnace equipment and temperature control apparatus, as well as welding equipment. In addition, the principal features of each item are described. This section will be doubly valuable if you cannot attend the show.

EXHIBITORS LIST

An alphabetical list of companies displaying equipment at the Metal Show will be found on pages 1024–1026. We give you each company's booth number, and the list of items to be seen there.

COMING

Scarcely any other plane zooms through the air at greater speed than the Bell Airacobra. It acquired its distinctive name because of its deadly striking power as a fighter. It is one of the prides of the Army Air Corps. Sometimes referred to as a "flying tank," this plane is produced by methods as advanced as its own design and performance. The Airacobra, in fact, is built on the first plane assembly line which moves mechanically and which simulates automobile production processes. In an early issue the details will be revealed of how the Airacobra is built. The jigs used in fabricating the main sections will be of special interest.

JUST SEND ONE DOLLAR

and ask for "Treatise on Planers". You will receive this helpful book containing complete data on planer operation.

. . . a modern machine for the production of modern milling machines at

KEARNEY & TRECKER

Here is a typical example of the use of modern machine tools in the production of other "up-to-the-minute" machines.

This 48" Hypro Planer with full electric control represents the last word in modern planer construction. It is shown here roughing the right and left dovetails of a Kearney & Trecker milling machine column simultaneously.

The material is cast iron, depth of dovetail 1¾", removing 1/16" stock, angle 40°, Feed .020" per stroke.

The increased rigidity built in and the added support given to cutting tools not only eliminates chatter under heavy feeds and fast speeds but assures greater output of accurate work.

When its a Planer job put it on a Cincinnati. Bulletin No. 135 gives complete details. Write for your copy today.

THE CINCINNATI PLANER COMPANY

CINCINNATI . OHIO . U.S.A.

ESTABLISHED 1877 **AMERICAN MACHINIST** BURNHAM FINNEY, Editor

METAL SHOW

SAID THE Prime Minister of Australia recently, "The man who is going to win or lose this war for our cause is the man who makes the stuff. . . . If we are wise, if we are realists, we will not be thinking half so much in terms of manpower as we will be in terms of machine power."

Machine power, which after all springs from a country's economic resources, is dependent upon two factors: an abundance of raw materials and the ability to convert those materials into guns, planes and ships and other munitions of war.

When raw materials are mentioned, one naturally thinks of steel. In the public mind it typifies all metals. A feeling of comfort and security arises when the orators refer to our nation being thoroughly protected if surrounded by a ring of steel.

Other metals, however, are just as essential as steel. Their use is an indispensable part of the country's armament program. Copper is one necessary material, aluminum is another. There are still others.

With such understandable emphasis on materials for defense purposes, the annual Metal Show comes at an opportune time. It serves to focus attention on America's great contributions to the field of metallurgy and how those contributions have been used to assure the country's safety.

Apart from metallurgy itself, developments in such essential manufacturing processes as welding and heat-treating are notable. Think for a moment of what welding has done to hasten and improve the production of planes and ships, not to mention numerous ordnance items. Think also about the superiority of armament which is so heat-treated that its equal is not produced elsewhere.

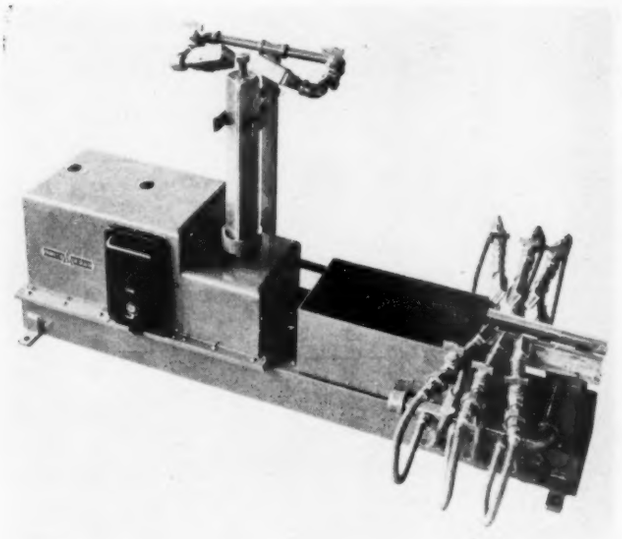
There have been many headaches in the perfection of these techniques. Heat-treating of armor plate is one sample of the troubles which the metallurgist and the production man have had. But in the end the tireless labor of these experts is the main factor responsible for manufacturers being able to turn out munitions of war better than those made in other countries and in larger volume.

At the Metal Show in Philadelphia you will see the latest developments of metals and their application in manufacturing processes. After seeing the show, you will have renewed confidence that the country which keeps its manufacturing industries abreast of the most modern production methods, and has the resources with which to use those methods to the best advantage, is in a strong position to resist the encroachments of an aggressor. For, as the Australian Prime Minister has said, the man who wins the war will be the man who makes the stuff. The country which is geared to a program of providing sufficient quantities of metals can produce the machine power which will win any way which may be forced upon it.

SHOW IN PRINT

New equipment, accessories and materials will be displayed at the National Metal Show in Philadelphia, Pa., Oct. 20-24

SELAS AUTOMATIC FLAME HARDENER



Complete flame-hardening machines, incorporating handling mechanism, time cycle control, burner assemblies, quench tanks and combustion controllers, are being designed and constructed for each particular application by the Selas Co., Erie Ave. and D St., Philadelphia, Pa. One unit semi-automatically flame hardens spindle heads and latch forgings.

Spindle station, at the left of the quench tank, incorporates a rotating seat, guide fork, and two opposed superheat burners. On the right of the tank there is the latch hardening station composed of a work piece slide and six burner heads. Flame temperatures are considerably higher than normally obtainable with gas-air combustion. Unusually high heat concentrations on local part areas can be obtained. Other units have been designed for valves, gears and saws.

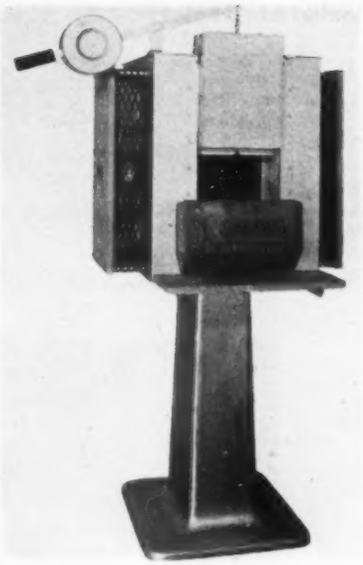
THERMONIC INDUCTION HEATING

Thermonic induction heating generators for surface hardening, brazing, melting, heat-treating, annealing and forging ferrous and non-ferrous parts have been introduced by Induction Heating Corporation, 791 Broadway, New York, N. Y. Current with a frequency as high as 500,000 cycles is transmitted through a copper tube coil, identified as the work or heating coil and shaped to the contour of the part to be heated. The highly magnetic field thus created causes two heat-producing phenomena, hysterisis and eddy currents. Forced changes in molecular structure create heat-generating friction. With non-ferrous metals heat is induced by eddy currents alone.

No moving parts cut maintenance costs. Thermonic power vacuum and rectifier tubes, designed with an overload factor of 50 percent, have average lives in excess of 7,000 and 9,000 hours, respectively. Melting temperatures above 5,000 deg. F. are obtained at a speed impossible with other heating media.

Other advantages claimed for this apparatus are: for surface hardening, localized heat without scale decarburization or distortion; for brazing, uniform union over full length of seam in one operation without oxidation or pitting; for annealing, accurate control of heat to produce products with uniform softness and structure; for forging, accurate temperature control without scaling and uniform heating which reduces metal loss, increases die life; and for heat-treating, uniform localized temperature without surface stoking.

SENTRY LARGE MODEL "Y" FURNACE



To harden high speed tools up to a maximum size of 4¾ in. x 4⅞ in. x 11 in., the Sentry Co., Foxboro, Mass., is making a size 4 Model "Y" electric furnace. Using the Sentry diamond block method, this furnace provides controlled atmospheres suitable for molybdenum, cobalt, or tungsten steels. Steel shells are of rugged construction and insulated for 2,500 deg. F. operation.

Removable muffle has inside dimensions of 6 x 6 x 13 in. Globar heating elements are located above and below the muffle to assure uniform temperatures. Heating from cold to 2,350 deg. F. takes about 75 minutes. Air cooling of terminals eliminates the usual water-cooling system. Designed for direct connection to 110 or 220 volt supply without transformer, this furnace has a maximum rating of 22½ kw. and in normal operation consumes 5 to 15 kw. per hr.

Two styles are offered. One is pedestal mounted and has an asbestos loading shelf with wire mesh terminal guards. The other, fitted with legs for bench mountings, does not have loading shelf or guards. Overall dimensions of the pedestal style are: width, 31¼ in., depth, 29¼ in., and height, 62¼ in., with the hearth 44¼ in. above the floor.

AJAX CORELESS FURNACES

Induction furnaces, which in groups of three have an hourly output of 140 shell heated for nosing, have been introduced by Ajax Electrothermic Corp., Trenton, N. J. These high frequency induction heaters operate on 960 cycle current. Shell production is speeded by fast, sure heating without increase in labor. The de-scaling process has been eliminated. Expensive nosing dies last longer in this process.

PARK NON-BURNING CARBURIZER

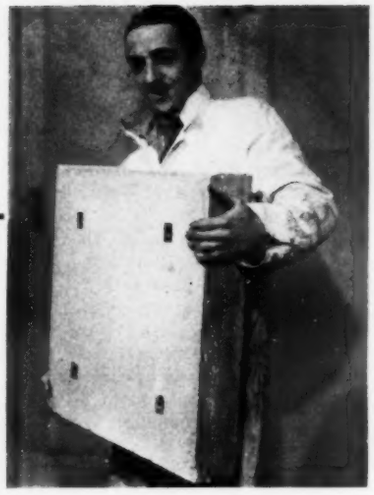
Park Chemical Co., 8074 Military Ave., Detroit, Mich., has developed a non-burning carburizer by coking crushed coal in such a manner that granules are impregnated throughout with energizer, rather than merely surface coated as in charcoal-coke compounds. Oxidization and shrinkage is held to a minimum because the coke does not burn after withdrawal from the hot furnace. Average shrinkage per heat for twenty heats is 2.0 percent, as compared with a 25 percent shrinkage on the first heat with charcoal-coke. This economy, coupled with a high ratio of old to new material (fifteen to one) and the extremely low weight of 25 lb. per cu.ft., create savings in some uses over gas carburizing.

OHIO CRANKSHAFT TWO-STATION INDUCTION HARDENER

Doubling the production capacity of the original one station 20 kw. "Tocco" Junior induction unit, the two-station machine introduced by Ohio Crankshaft Company, 6600 Clement Ave., Cleveland, Ohio, is operated by one worker. He prepares one fixture, while the other is hardening. This unit also is easily adapted for brazing, heating for forging, stress relieving and soldering.

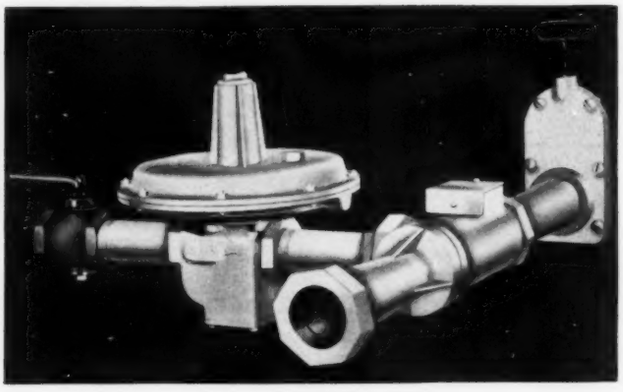
Inductors are fastened to two rotatable transformer panels. A high frequency motor generator, supplying 9,600 cycles of high frequency current at 220 volts, furnishes the power. Of all welded construction, the machine occupies 36 x 48 in. of floor space. The generator is mounted on a three-point suspension in order to insure level operation under all conditions.

QUIGLEY REFRACTORY BRICK



Light weight precast refractory panels, ready for assembly by inserting necessary fastening bolts are being made by the Quigley Co., Inc., 56 W. 45th St., New York, N. Y. They have low-heat storage and high insulating properties. Other refractory forms include brick, blocks and lagging.

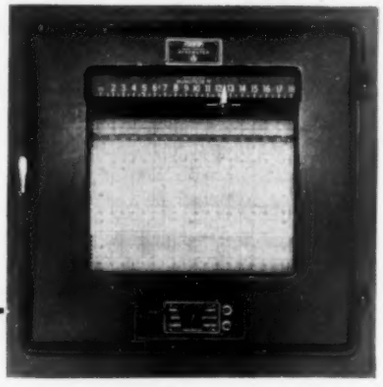
NATIONAL MACHINE PROPORTIONAL MIXERS



Gas-air mixtures for premixing gas burner ports used in heat-treating, drawing, enamel burning and crucible furnaces; soft metal, fusion and galvanizing kettles; salt pots and calcining kilns, are accurately controlled by proportional mixers made by the National Machine Works, 1559 N. Sheffield Ave., Chicago, Ill. These mixers have been performance rated for over 50 different size flow orifices with capacities ranging from 25,000 Btu. to 10,000,000 Btu. per hr.

By utilizing the entrainment principle of a Venturi, precise single valve control of gas-air mixture ratios are obtained with exceptionally wide range of burner turndown. CO_2 in the combustion is maintained within $\pm$ 0.5 per cent. As the gas is entrained from a zero pressure regulated source, high pressure gas is unnecessary. Use of air from an economical low pressure source, fan or blower, eliminates compressed air, which in many instances would cost more than the fuel gas. All types of blast combustion flame ports can be used with these mixers.

FOXBORO MULTIPLE POTENTIOMETER RECORDER



As many as 12 temperature records can be made on the multiple point recorder made by the Foxboro Co., Foxboro, Mass. Each record is kept in a separate colored dot or numeral on a 12-in. chart.

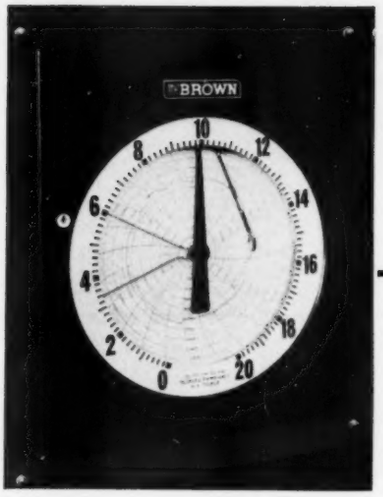
To prevent transmission errors slide wire contacts, and recording carriage assembly are integral parts of the instrument. Three selective chart speeds are provided.

A large indicating scale and pointer can be accurately read directly. Instrument case is dust, moisture and fume tight. It can be flush or flat mounted on panel as desired.

FOXBORO POTENTIOMETER INDICATORS

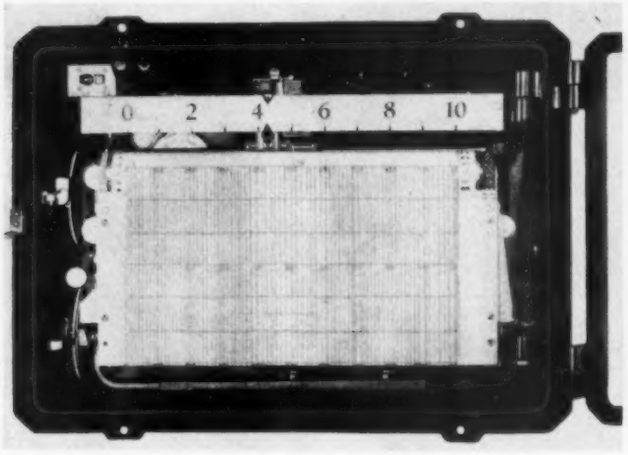
Accurate readings of as many as 18 thermocouple circuits can be taken in rapid sequence with the potentiometer indicators introduced by the Foxboro Co., Foxboro, Mass. A vernier dial knob is main factor increasing speed. Seventeen inch scale is mounted on a 6 in. diameter dial. A large selection of standard dials with both single and double range scales is offered. Extra switch panels are supplied for any number of circuits. Other models are available with built-in switches for as many as 84 circuits.

BROWN CIRCULAR CHART POTENTIOMETER



The circular chart potentiometer introduced by Brown Instrument Co., 4501 Wayne Ave., Philadelphia., Pa., is unaffected by vibration and designed to be continuously balanced for perfect operation in any position. Calibrated for standard thermocouples and wiring it, therefore, is interchangeable with present pyrometer installations. It consists of a conversion stage, containing a converter and imput transformer. An amplifier, operating in conjunction with a balancing motor, transmits movement to slide-wire contact, pointer and pen arm.

TAGLIABUE PROPORTIONING CONTROL



Tempeature over-shooting is prevented with the Celectray proportioning controller announced by C. J. Tagliabue Mfg. Co., Park and Nostrand Aves., Brooklyn, N. Y. This fuel heat throttler, employing only a control instrument and valve mechanism, eliminates the relay detector element, formerly required. In practice, when the temperature is far below the control point, the valve is wide open; as the temperature rises and enters the throttler zone, the valve will gradually close. Throttling zone can be readily adjusted within wide limits, according to the lag characteristics required. Load error is kept within a few degrees without resetting. Manual and automatic reset adjustments are available. The small dead zone greatly improves maintenance of continuous straight line control.

OHIO COMMUTATOR BURNISHERS

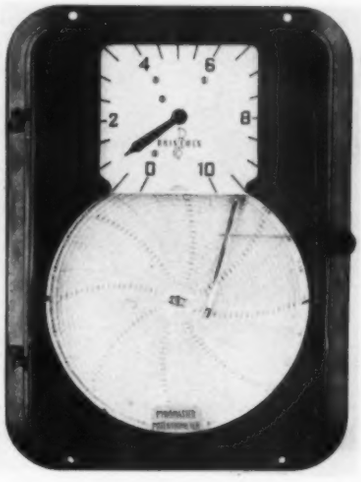
Film and glaze can be removed from commutators without cutting action by the burnisher introduced by the Ohio Carbon Co., 12508 Berea Rd., Cleveland, Ohio. Honing is possible to a degree not reached with the finest cutting tools. Operator merely holds the burnisher firmly against the commutator until film and glaze are removed. The slots do not fill up, and often material which is already deposited in the slots is pulled out.

BRISTOL "PYROMASTER" POTENTIOMETER

The "Pyromaster" round chart potentiometer controller, introduced by the Bristol Co., Waterbury, Conn., has no continuously moving parts. Resistant to plant vibration, it does not require lubrication.

Chattering at control contacts has been eliminated. A wide throttling range and reset control adjustments are provided. Temperature to be maintained up to 1,000 F. is set with the small white hand on the clock-like dial. Actual temperature is shown by the black hand.

Using a Unitact system, potentiometer is operated on electric circuit. Equipped with a free-vane, it is an air operated control. Temperature record is kept on a round chart.



BRISTOL ELECTRONIC CONTROLLER

A pyrometer controller embodying an electronic circuit has been developed by the Bristol Co., Waterbury, Conn. Temperatures are transmitted by the electron circuit so that it operates without moving parts in the control mechanism, such as motors, depressor bars, toggle switches and open contacts.

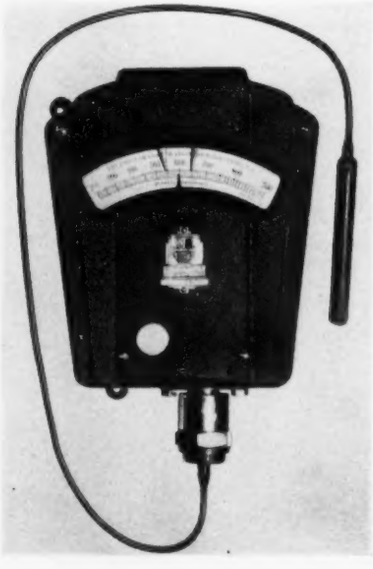
A large bull's eye pointer is used to set the temperature to be maintained, while a small pointer moved across the strip dial by the electron current indicates actual temperatures. Scale reads from 0 to 2,000 F. in 10 deg. units. Case can be flush mounted if that is desired.

KENT AIR DRAWING OVEN

An air drawing oven, with an internal capacity 36 in. wide by 24 in. high by 24 in. deep, has been developed by Harold E. Trent Co., 55th and Wyalusing Avenue, Philadelphia, Pa. It can be used where temperatures up to 600 deg. F. are required. A fan blade in the roof circulates air and holds temperature to a plus or minus 5 deg. Heating elements with large surface areas are on the side walls. Inside finish is acid proof.

MANHATTAN WET ABRASIVE CUT-OFF MACHINE

Improved coolant supply through the wheel spindle is featured in the Jacobsen "lightning cut" wet abrasive cut-off machine, made by the Manhattan Rubber Mfg. Div., Raybestos-Manhattan, Inc., Passaic, N. J. Coolant is delivered from a 95 gal. tank to both sides of the wheel through grooves in the face of both flanges. Thus, a constant and copious supply is assured regardless of the size of material being cut or the point of cutting stroke. Even flow on both sides is assured. Designed for heavy-duty cutting, the machine is equipped with a 10 hp. motor.



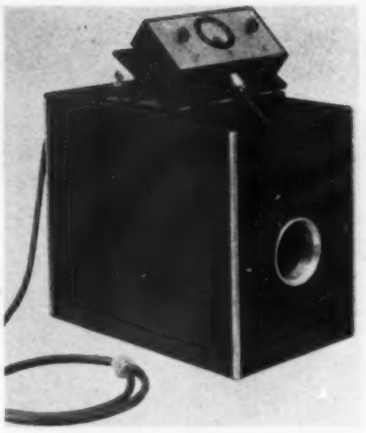
PARTLOW TEMPERATURE CONTROLLER

Two independent temperature controls are incorporated in a single instrument manufactured by the Partlow Corp., 2 Campion Rd., New Hartford, N. Y. Known as Model B, this controller has a single thermal element and scale. Temperature settings of both control points is made with a knurled knob on the outside of the case. There is a pair of make and break silver contacts for each control point which close an associated relay provided with an interlock circuit.

An example of the two-point controller's use is in continuous heating equipment. Used in conjunction with an electric time clock, it holds temperature at a low standby heat and automatically raises it to the operating heat. At the end of the manufacturing period temperature returns to the standby point.

Another application is in equipment where sudden temperature changes are required. One control point and burner is set at the normal temperature, while the other is regulated a few degrees below this point. Maximum heat is supplied by both burners until the lower temperature is reached. Then, the burner set at lowest temperature is automatically shut off and the other continues operation until the normal temperature is reached. Thus, overshooting is minimized.

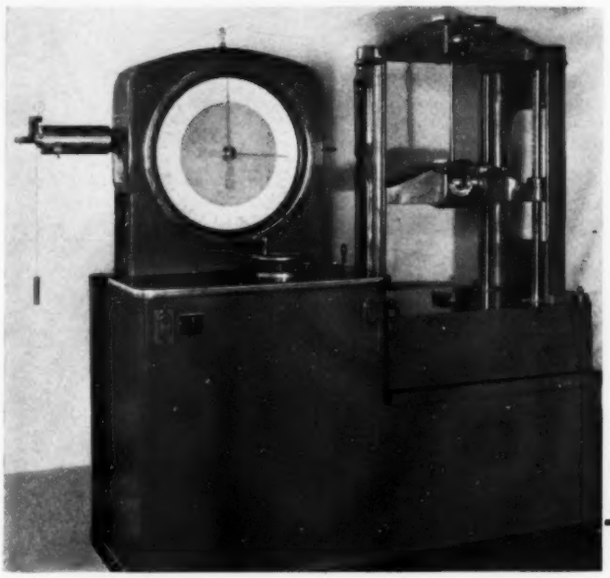
MAGNETIC ANALYSIS DEMAGNETIZER



Steel products, susceptible to magnetization which interferes with their use, can be demagnetized with the equipment manufactured by Magnetic Analysis Corp., 42-44 Twelfth Street, Long Island City, N. Y. A combination a.c.-d.c. coil capable of taking material up to 3 in. in diameter is employed in the unit. Required d.c. strength is adjusted by controls. Simultaneous use of both currents permits complete demagnetization. Apparatus may be directly combined with standard types of straightening equipment.

SCULLY HARD FACING ELECTRODES

Six types of hard facing welding electrodes are offered in a line developed by the Scully Steel Products Co., 1319 Wabansia Ave., Chicago, Ill. They are econoloy for self-hardening; ranalloy "C" for general work at low cost; ranalloy "A" for general work at medium cost; ranalloy "B" for extreme abrasion resistance; supraloy for extreme hardness and Corosoloy for corrosion abrasion resistance. Easily applied to a.c. or d.c. with regular or reversed polarity, they are slag free, can be laid bead over bead without chipping, and create a dense deposit.



RIEHL TESTING MACHINE

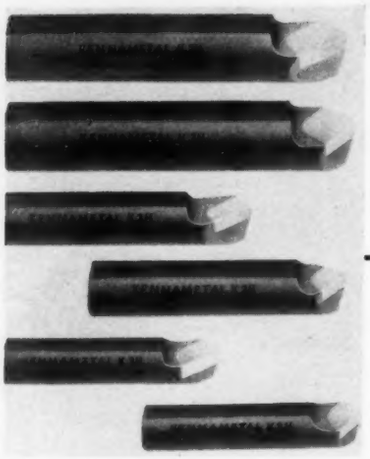
A 60,000 lb. capacity universal screw power testing machine with variable speed drive and pendulum load indicator has been developed by Riehl Testing Machine Div., American Machine and Metals, Inc., East Moline, Ill. It has five load ranges of 0 to 3000, 6000, 15000, 30000 and 60000 lb. Uniform load distribution is assured by the tripod arrangement of pulling screws. Compression or transverse table form together with the upper gripping head and side columns, a cage which is supported by a knife edged lever system. Knife edges, also, support table at the four corners. One handwheel controls testing speeds, which are indicated on a large dial. The machine is 74 in. wide, 39½ in. deep and weighs 5,600 lb.

RIEHL BRINNELL HARDNESS TESTER

Although hand operated, the hydraulic brinnel hardness tester, introduced by Riehl Testing Machine Div., American Machine & Metals, Inc., East Moline, Ill., equals power driven machines in convenience and ease of operation. The machine is equipped for three standardized brinell loads of 500, 1,000 and 3,000 kg.

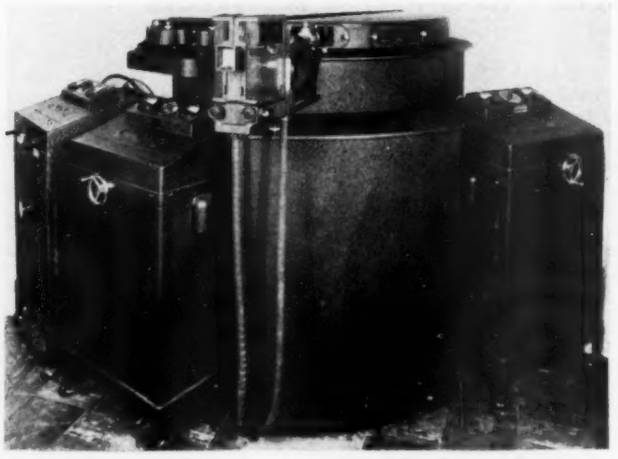
Loads are indicated by the rise of accumulator weights, the highest position of the weights being limited by an automatic oil bypass. Distance between ball indenter and supporting platens is adjustable between 0 and 13 in. by means of a hand wheel and a removable table post. Connection between plunger and gear is such that with increasing penetration and load, the lever arm becomes shorter.

Because of this toggle action the load of 3,000 kg. can be produced with a handwheel force so small that the machine may be employed in production service without tiring the operator. Dimensions of the machine is 42 in. high, 15 in. wide, 23 in. long. It weighs 380 lb.



McKENNA BORING TOOLS

Kennametal tools with round shanks for use in 30 deg. and 45 deg. boring bars have been announced by McKenna Metals Co., 103 Lloyd Ave., Latrobe, Pa. Known as styles 27-R and 29-R, they are tipped either for usual machining for precision boring and finishing cuts. The 12 deg. positive back rake compensates for the negative effect of these tools when held at ½ the above center height. Tolerance on the round shanks is ±0.001 in.



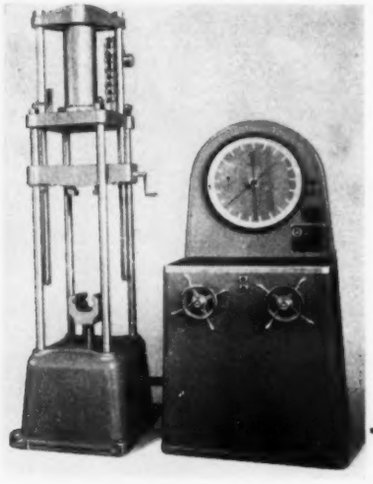
DIETERT SPECTROGRAPH TESTERS

A wide range of spectro analyses can be performed with the Arl-Dietert spectrograph which the Harry W. Dietert Co., 9330 Roselawn Ave., Detroit, Mich., has arranged with three electric source cabinets. The source units which supply the electric power of definite characteristics to the atomized metal specimen samples held in the spark or arc gap of the spectrograph, are the 35,000 volt spark cabinet, the 5,000 volt a.c. arc cabinet, and the 220 volt d.c. arc unit.

In operation the light from the spark or arc gap is composed of different colors as emitted by the different elements of which the metal is composed. Each element gives off light of certain wave length or color. After sorting out all the color bands, the spectrograph photographs them on a strip of motion picture film. With a comparator-densitometer, the percentage of each element in the sample can be determined. Nine samples may be placed on one strip of film.

THOR "AIRCRAFT" DRILLS

A series of light-weight Thor ¾ in. aircraft drills have been announced by the Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago, Ill. They are particularly useful for operation in limited space. Equipment includes a Jacobs chuck, 10 ft. of 3 wire cable, ground wire and attachment plug. It is furnished in three speed sizes of 2,500 r.p.m. for ordinary production drilling, and 3,750 or 5,000 r.p.m. for drilling in light materials. The first weighs 4⅜ lbs. and is 7¼ in. long. The last two weigh 4¼ lbs. each and are 7¼ in. long.



BALDWIN SOUTHWARK TESTING MACHINE

Southwark-Tate-Emery testing machines of 20,000 and 60,000 lb. capacities have been added to the line manufactured by Baldwin Southwark Div., the Baldwin Locomotive Works, Paschall Station, Philadelphia, Pa. The 20,000 lb. machine, designated as Model 20-35, was designed for plastics, while the other, Model 60-35, was built for rapid routine testing of metals.

Accuracy is guaranteed within 0.75 of one per cent of load or 0.15 of one per cent of range, whichever is greater. Lapped ram principle load application is employed. Central and lower gripping heads are adjustable for convenient positioning of the specimen.

Two or three dial ranges are provided on the load indicating unit and are arranged to permit instant range change without interrupting tests. Using a recorder equipped 60-35 machine, a single operator can run at least 15 production control tests per hour. The autographically recorded charts need only be blueprinted to supply manufacturer and customer with full permanent record of each test.

BUEHLER ABRASIVE CUT-OFF MACHINE

Sectional cutting without the necessity of a hydraulic feed can be performed with the abrasive cut-off machine recently designed by Adolph I. Buehler, 228 N. LaSalle St., Chicago, Ill. This operation is permitted because cutting is done at the front of the wheel, rather than at the bottom. Completely inclosed for the operator's protection, this machine is so designed that the operator has full control at all times.

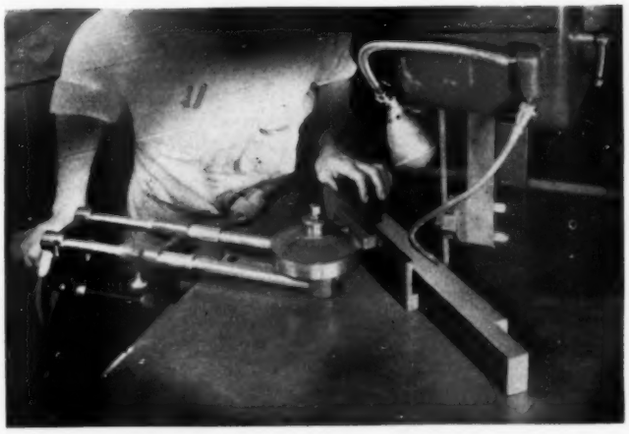
A heavy wired-glass window and built-in light provide a view of the work while the machine is running. Inclosed design furthermore makes possible a flood of water for guaranteed cool cutting. Crank operated leadscrew with lock device permits resetting of specimens during sectional cutting. Operating mechanism is mounted inside the cabinet. Steel spindle is driven through a multiple belt drive by a 3 hp. electric motor. A drawer in the front compartment collects sludge. Recessed bottom of the cabinet gives ample foot room for the operator.

EASTMAN INDUSTRIAL X-RAY FILMS

To meet needs brought about by the increase in use of x-ray and radium to examine materials, the Eastman Kodak Co., Rochester, N. Y., has produced three Kodak industrial x-ray films. One, Code 5134, is designated for examination of moderately thick parts where minimum exposure times are essential. Calcium tungstate intensifying screens are used with this type.

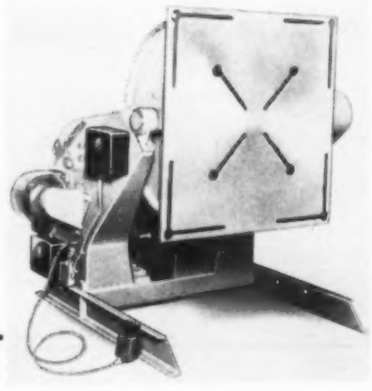
Suggested for use with lead foil screens, film, Code 5135, is coated with a highly sensitive emulsion. It is recommended for gamma radiation (radium) in work requiring maximum sensitivity and contrast. A fine grain film, Code 5141, is suitable for examination of aluminum alloy castings and other work where it is essential that fine details be recorded

CONTINENTAL MITERING HEAD



Notching, squaring, ripping, and mitering without excessive set up delays can be performed with Doall mitering attachment, manufactured by Continental Machines, Inc., 1203 Thacker St., Minneapolis, Minn. The unit, adapted for manual or power feeds, is quickly mounted on the work table. Attached to the front instead of the side, it does not interfere with the removal of filler plate. Mitering head is attached to slide rods and carried by the slide rod brackets mounted above the guide. A removable guard gives protection against sawing into the head. Manual operation is accomplished by a 6 in. handwheel through a screw engaging an internally threaded tube on the rod bracket. For power feeding the threaded tube is disengaged.

RANSOME WELDING POSITIONER



A heavy-duty 3,000 lb. welding positioner is being manufactured by Ransome Concrete Machinery Co., Dunellen, N. J. It has a 40-in. square machined steel table top, provided with four radial and four longitudinal T slots which take $\frac{3}{4}$ in. bolts. A 3,000 lb. load with a center of gravity 12 in. above table may be carried 12 in. eccentric from center of table. A tilting motor tilts the table from horizontal to 45 deg. beyond vertical. Table top can be rotated at constant or variable speed. Remote pushbutton controls are provided.

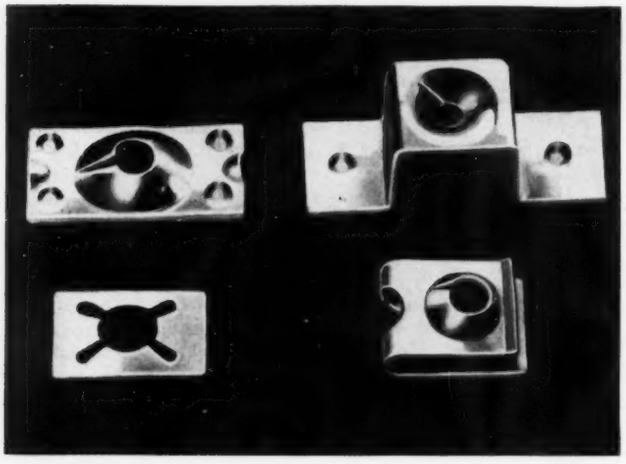
OZALID AUTOMATIC WHITEPRINTER

Ozalid Products Div., General Aniline & Film Corp., Johnson City, N. Y., has announced a new Model "C" automatic Whiteprint machine. It is synchronized to print and develop sensitized materials at speeds up to 12½ ft. per min. Prints are delivered at either front or rear, allowing operator to feed the original and the sensitized material into the front of the machine and receive the finished prints on the delivery tray in front, or on the sorting table at the rear.

Sensitized material and original are automatically separated; even cooling insures uniform light distribution and long life for the high pressure mercury vapor type lamp. A slight vacuum created in the machine prevents leakage of ammonia fumes. An adjustable burner shade allows variations in light intensity without changing the printer speed. Materials up to 42 in. wide can be used. The machine requires only 19 sq. ft. of floor space.

PHILLIPS PORTABLE DEGREASER

For degreasing light metal parts, stampings, screws, dies, tools and instruments, the Phillips Mfg. Co., 340 W. Huron St., Chicago, Ill., has developed a Model 14 bench-type "Phill-Co" portable degreaser. Operating on 110 volt a.c. or 115 volt d.c., at 15 amp., this machine has a solvent capacity of two gallons.



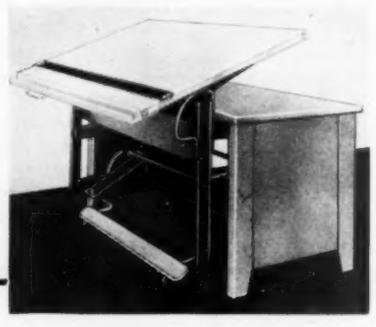
CENTRAL "VIBRISIST" LOCK NUTS

Designed especially for application in the aircraft industry, the "Vibrisist" lock nuts manufactured by the Central Screw Co., 3501 So. Shields Ave., Chicago, Ill., have full constant pitch threads, and apply fatigue-proof pressures. Pressed from cold-rolled steel, these "prestoles" have a resilient, conically formed slit-thread which locks the assembly. Included in this line is a spring steel, push-on type fastener for one-time assemblies. These lock nuts create a vibration proof assembly that will operate in high heat, oil, water and salt spray conditions. They will not damage airplane finishes used on sheet metal.

ALOX CORROSION COMPOUNDS

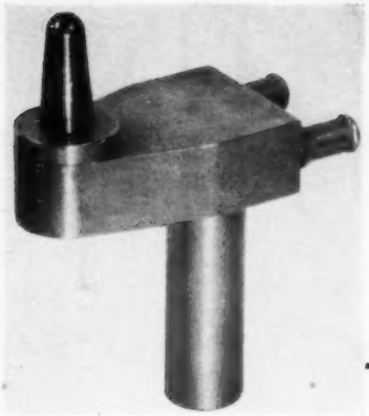
Inhibitors for the control of corrosion in water and other systems such as alcohol-water-metal and gasoline-metal-water, have been developed by the Alox Corp., 3943 Buffalo Ave., Niagara Falls, N. Y. Another recently made corrosion preventive compound, known as Par-al-ketone base inhibitor, is used to protect exterior surfaces of airplanes.

HAMILTON AUTO-SHIFT DRAWING TABLES



Drawing board, reference surface, reference drawer, tool drawer and filing space are efficiently arranged in the auto-shift drawing tables recently designed by Hamilton Mfg. Co., Two Rivers, Wis. When the tables are placed in a row, each draftsman uses the drawers and top of the tables directly behind him. The drawing board, which can be instantly adjusted to any height or slant, comes in three sizes: 36 x 60 in., 36 x 72 in., and 42 x 72 in.

It locks into desired position. Height adjustments range from 33⅞ to 45 in., and it has zinc plated end cleats. The table is made of heavy gage welded steel with a top 30 x 60 in. and 30¼ in. above floor.



MALLORY OFFSET ELECTRODE HOLDER

An offset electrode holder has been fabricated from wrought copper base alloys of high strength by P. R. Mallory & Co., Inc., 3029 E. Washington St., Indianapolis, Ind. It incorporates a patented tip knockout device which makes it possible to easily and quickly replace worn out spot welding points.

Tip socket is replaceable; so when the tapered seat for the electrode becomes worn, it can be renewed without obtaining an entirely new holder. Alloys for each part have been carefully selected to give maximum service. This holder gives long service, saves operator's time and eases his work.

TIME-TEMPERATURE SYSTEM BY "ATC" CO.

Heating and cooling processes can be controlled with straight line rate of increase or decrease in temperature with the control system, recently introduced by Automatic Temperature Control Co., Inc., 34 E. Logan St., Philadelphia, Pa. The time-temperature unit includes two adjustments. One regulates rate of increase or decrease in degrees per hour. The other controls the number of hours during which the rate is to be maintained. This controller can be set up in any two position, three position or proportioning control system. Case is dust tight and is suitable for flush or surface mounting.

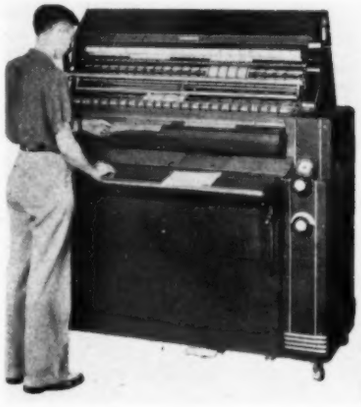
PULMOSAN RESPIRATOR

Protection from fumes created by spraying of paints, enamels, lacquers and chemicals is provided by the model M-3-C respirator, introduced by the Pulmosan Safety Equipment Corp., 176 Johnson St., Brooklyn, N. Y.

It has an aluminum body that is easily shaped to fit facial contours by bending and a non-toxic molded rubber face cushion. Breathing resistance has been reduced with no increase in size of respirator.

MORSE WATCHMAN'S CLOCK

Order of stations visited by the watchman, as well as hour, minute and station number is recorded on the tape clocks manufactured by the Morse Magneto Clock Co., 17 E. 42nd St., New York, N. Y. Furthermore, each watchman has an individual key with a letter which identifies his tours on the clock tape. Nearly 1,000 stations can be used on one clock. Three days' records can be kept without change of paper. Under ordinary systems week-end records were hard to keep; charts had to be changed each day otherwise records were superimposed on each other.



BRUNING HIGH SPEED DEVELOPER

Designed for use with the Bruning model 75 BW printer, the No. 159 Volumatic developer, announced by Charles Bruning Co., Inc., 100 Reade St., New York, N. Y., permits entire printing and developing operation on sensitized paper by one operator. Paper and tracings are fed into the machine at the front. After exposure, vacuum separates the tracings, returning them to the operator, while prints continue through the developing and drying section to the delivery tray at rear of machine.

EXHIBITORS

National Metal Exposition

CONVENTION HALL, PHILADELPHIA, PA., OCTOBER 20-24, 1941

(Booth number follows company name)

Abrasive Co. (G-39). Grinding wheels and abrasive materials.

Acme Electric Welder Co. (A-6). Spot, butt, flash, seam welders.

Acme Industrial Co. (H-51). Drill jig bushings.

Adirondack Foundries & Steel Co. (298). Castings.

Advance Polishing Wheels, Inc. (G-34). Polishing and buffing wheels.

Ajax Electric Co., Inc. (211). Ajax-Hultgren electric salt bath furnace for heat-treating with a development for combination brazing and carburizing.

Ajax Electrothermic Corp. (211). Ajax-Northrup induction melting and heating furnaces.

Allen Manufacturing Co. (B-39). Safety set, cap and shoulder screws; dowel pins and pipe plugs.

Allis-Chalmers Mfg. Co. (86). Arc welders, pumps, motors and drives.

Alox Corp. (62). Corrosion preventive compounds and lubricating materials.

Aluminum Co. of America (52). Aluminum alloys and products.

Aluminum Ore Co. (52). Alorco activated alumina and apparatus.

Alvey-Ferguson Co. (C-54). Conveyors, washing machines.

American Brake Shoe & Foundry Co. (D-23). See American Manganese Steel Division.

American Brass Co. (278). Welding rods, brass and special alloy products.

American Car & Foundry Co. (270). Automatic rivet and bar heaters.

American Chain & Cable Co. (A-27). Abrasive cutting and nibbling machines, welding electrodes and gas welding wire.

American Foundry Equipment Co. (D-61). Blast cleaners.

American Gas Furnace Co. (C). Heaters, furnaces, burners and appliances.

American Gasifier Co. (F-54). Heat-treating units.

American Machine and Metals, Inc. (D-29). Riehl testing machines.

American Magnesium Corp. (52). Magnesium alloys.

American Manganese Steel Div., American Brake Shoe & Foundry Co. (D-23). Heat-resisting castings and containers, Hoffman Flexbox sectionalized container and welding materials.

American Rolling Mill Co. (F-31). Armco metal sheets for air raid and munitions shelters, electro-polished stainless steel and sheet metal articles.

American Steel Castings Co. (298). Castings.

Ampco Metals, Inc. (F-50). Forged and extruded bar stock, castings, rough and machined parts, and welding rods.

Arcos Corp. (12). Electrode dipping machine, welding rods and accessories.

Armstrong Cork Co. (D-35). Fire bricks and cement.

Atlantic Steel Castings Co. (298). Castings.

Audubon Wire Cloth Corp. (D-21). Metal conveyor belts, wire cloth, manganese forgings and rolled products.

Automatic Temperature Control Co., Inc. (31). Valve operators, time-temperature control systems, position indicators and temperature controllers.

Babcock & Wilcox Co. (27). Refractories.

Baker & Co., Inc. (G-43). Platinum laboratory equipment, chemical equipment, thermocouples, protection tubes, atmospheric furnaces and platinum resistance coal ash analysis furnace.

Baldwin Locomotive Works (E-6). Locomotives.

Baldwin Southwark Div., Baldwin Locomotive Works (E-6). Testing machines.

Barrett-Cravens Co. (G-47). Lift trucks and storage racks.

Bausch & Lomb Optical Co. (F-46). Optical instruments.

Bennett Insured Steel Treating Co. (B-54). Heat-treating.

Bethlehem Steel Co. (D-6). Carbon and alloy steels, strip and wire.

Birdsboro Steel Foundry & Machine Co. (298). Castings, dies and presses.

Black & Decker Mfg. Co. (44). Portable electric abrasive tools and drills.

Black Drill Co. (B-29). Hardsteel drills.

Botfield Refractories Co. (A-16). Fire brick and insulation.

Bradley Washfountain Co. (B-22). Washfountains and multi-stall shower.

Bridgeport Brass Co. (H-38). Brass and copper.

The Bristol Co. (66). Round chart potentiometer controller, time-temperature controller, strip chart potentiometer controller and pyrometer controller using a new electronic circuit.

Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co. (63). Continuous balance circular chart potentiometer, radiamatic pyrometer; program control, proportioning control, multiple-recording potentiometer pyrometers; thermometers and pressure gages.

Charles Bruning Co., Inc. (A-22). Drafting and surveying equipment and supplies.

Brush Development Co. (26). Meter for testing surface smoothness and an oscillograph.

Bryant Heater Co. (Q). Furnaces, unit heaters and air conditioners.

Budd Induction Heating, Inc. (F-22). Induction heaters.

Adolph I. Buehler (30). Cutters, grinders, polishers, microscopes, micro camera, hardness testers, titrator, carbon meter, and pH meter for the metallurgical laboratory.

Burkay Co. (P). Water heating equipment.

H. W. Butterworth & Sons Co. (H-47). Rough and finished castings.

Callite Tungsten Corp. (G-54). Electrical contacts, lamp parts, facing materials, machinery, tungsten, molybdenum and special alloy products, dies, tools, nibs and blanks.

Cambridge Wire Cloth Co. (C-17). Wire cloth, screen conveyor belts, baskets and crates.

Campbell Div., Andrew C., American Chain & Cable Co., Inc. (A-27). Abrasive cut-off and nibbling machines.

Canadian Radium & Uranium Corp. (C-28). Equipment used in making of radiographs.

Carboloy Co. (E-34). Cemented carbides.

Carborundum Co. (236). Abrasive and refractory products.

Carnegie-Illinois Steel Corp. (Stage). Carbon and alloy steels and high tensile steels.

Carpenter Steel Co. (254). Tool and stainless steels.

Central Screw Co. (220). Locknuts for aircraft.

Chapman Valve Mfg. Co. (204). Heat-treating process.

Chase Brass & Copper Co., Inc. (F-30). Brass and copper products, welding rods and alloys.

Chicago Flexible Shaft Co. (74). Heat-treating furnaces.

Cities Service Oil Co. (F-45). Lubricants and cutting oils.

Cleveland Overall Co. (B-16). Industrial clothing.

Climax Molybdenum Co. (D-1). Molybdenum steels and irons.

Coffing Hoist Co. (C-51). Ratchet lever, electric and spur gear chain hoists.

Colonial Alloys Co. (G-11). Stainless alloys and products.

Continental Industrial Engineers, Inc. (19). Heat-treating furnaces.

Continental Machines, Inc. (B-46). Contour saws, files, polishers and surface grinder.

Copperweld Steel Co. (B-6). Stainless, corrosion, heat resisting, carbon tool, special and fine steels.

Cramp Brass & Iron Foundries (E-6). Bearings, bushings and castings.

Crucible Steel Casting Co. (298). Crucible and tool steels.

Cyclone Fence Co. (Stage). See U. S. Steel Corp.

Deemer Steel Casting Co. (298). Castings.

A. P. deSanno & Son, Inc. (C-30). Abrasive wheel cut-off machines for wet and dry cutting, grinding wheels, cut-off disks and abrasive mounted points and stones.

Despatch Oven Co. (4). Gas heat-treating furnaces.

Detroit Electric Furnace Div., Kuhlman Electric Co. (E-50). Electric furnaces, automatic electrode control and transformer.

Detroit Rex Products Co. (282). Degreasing and cleaning machines.

Detroit Testing Machine Co. (208). Hardness and other testers.

Diamond Iron Works, Inc. (7). Saws.

Harry W. Dietert Co. (258). Spectrographic equipment for analysis of metals, carbon and sulphur determinators and sand testing equipment.

Henry Disston & Sons, Inc. (F-58). Saws, knives, steel and tools.

A. L. Hartley *of R. K. LeBlond will tell the Welding Society about "Uses of Flame Hardening in Machine Tool Production"*

Stephen Smith, *of Air Reduction, to deliver A. W. S. paper on "Flame Hardening Internal, External Round Surfaces"*

J. B. Austin *of U. S. Steel Corporation will lecture on "Heat Flow in Metals" before American Society for Metals*

A. B. Kinzel, *well known Union Carbide metallugist, will deliver a paper on "The Specification of Weldability of Steels"*

Do-All Eastern Machine Co. (B-46). See Continental Machine Co.

Dodge Steel Co. (298). Castings.

The Dow Chemical Co. (G-61). Magnesium allows, castings, sheet, strip and plate, extruded shapes, bars, rods and forgings, fabricated parts.

Drever Co. (H-22). Heat-treating furnaces.

Driver-Harris Co. (214). Heat and corrosion resisting alloys.

Eastman Kodak Co. (H-39). Industrial X-ray film and accessory equipment.

Ecco High Frequency Corp. (C-38). High frequency converters.

Eclipse Fuel Engineering Co. (H). Gas-fired melting furnace, bell type furnace and centrifugal pressure blower.

Eisler Engineering Co. (A-50). Spot, butt and arc welders.

Elastic Stop Nut Corp. (G-31). Self-locking nuts.

Electro Manganese Corp. (90). Electrolytic manganese.

Electroloy Co., Inc. (A-6).

Empire Steel Castings, Inc. (298). Castings.

Eutectic Welding Alloys, Inc. (A-11). Alloys for low temperature welding.

Expert Welding Machine Co. (A-6). Welders.

Farrand Foundry Corp. (G-38). Castings.

Farrel-Birmingham Co. (298). Gears and coupligs.

Federal Machine & Welder Co. (A-6). Electric spot, butt, projection and seam welders.

Fieser-Lundt, Inc. (B). Gas burners, compressors and blowers.

Firth-Sterling Steel Co. (98). Lathe tools, gages, dies and mandrels.

Foxboro Co. (F-12). Indicating, recording and automatic controlling pyrometers.

Gehnrich & Gehnrich, Inc. (M). Ovens, dryers and heaters.

General Alloys Co. (2). Heat and corrosion resistant alloys, containers and parts for heat treating furnaces.

General Electric Co. (230). Gas carburizing furnace. box-type furnace, motors and welders.

General Electric X-Ray Corp. (230). Industrial X-ray machines.

General Gas Light Co. (T). Gas unit heaters.

General Steel Castings Corp. (298). Castings.

Globar Div., Carborundum Co. (236). Electric heating elements.

Claud S. Gordon Co. (208). Heat treating furnaces.

Grob Bros. (H-51). Die making equipment, saws, filing machines and brazing devices.

Gulf Oil Corp. (G-36). Lubricants and cutting oils.

H & H Research Co. (222). Portable electric tools.

Hamilton Mfg. Co. (G-30). Drafting tables and filing equipment.

Handy & Harman (C-40). Brazing solders.

Charles Hardy, Inc. (G-13). Metal powders and products.

Harnischfeger Corp. (82). Arc welders, electrodes and electric hoists.

Hartford Electric Steel Corp. (298). Castings.

Hauck Mfg. Co. (A-23). Oil circulating system, proportioning burners and micro cam oil regulating valves.

C. I. Hayes, Inc. (C-34). Heat-treating furnaces.

Hevi-Duty Electric Co. (E-30). Laboratory equipment.

Hild Floor Machine Co. (H-59). Electric floor scrubbing machine and industrial vacuums.

Hobart Bros. Co. (D-39). Arc welders.

W. J. Holliday & Co. (F-38). Speed case and speed treat steels.

Holo-Krome Screw Corp. (E-26). Wrenches and screws.

Charles A. Hones, Inc. (L). Pot and oven furnaces and burners.

E. F. Houghton & Co. (60). Rust preventive coatings, cutting oils, carburizers, drawing compounds, lubricants and leather packings.

Hunt Spiller Mfg. Co. (298). Air furnace and castings.

Illinois Testing Laboratories, Inc. (76). Indicating pyrometers, resistance thermometers, controllers and air velocity meter.

Independent Pneumatic Tool Co. (C-21). Portable electric drills, screwdrivers, nut setters, sanders, grinders, saws, hammers and nibblers.

Induction Heating Corp. (G-26). High-frequency induction generator and equipment.

Ingersoll Steel & Disc Div., Borg-Warner Corp. (C-26). Alloy stainless clad and tool steels.

International Nickel Co. (D-26). Nickel and its alloys.

Jackson Buff Co. (H-6). Buffing wheels.

Jessop Steel Co. (13). Stainless clad steel and high-speed steels.

Johns-Manville Sales Corp. (H-12). Insulating and refractory materials.

Jones & Laughlin Steel Corp. (216). Hot and cold rolled steel.

Kelley-Koett Mfg. Co. (C-57). Industrial X-ray equipment.

C. M. Kemp Mfg. Co. (1). Gas carburetors and mixers.

The Kent Co., Inc. (C-49). Electric mopper and floor machine.

Andrew King (B-31). Consulting engineer.

Krouse Testing Machine Co. (212). Testing machines.

Kuhlman Electric Co. (E-50). Electric furnaces.

Latrobe Electric Steel Co. (15). Castings.

Lebanon Steel Foundry (298). Castings.

Leeds & Northrup Co. (20). Heat-treating furnaces, pyrometers and control instruments.

Lepel High Frequency Laboratories, Inc. (229). High frequency converters.

Lewis Machine Co. (C-58). Wire straightening and cutting machinery.

L'Hommedieu & Sons Co. (E-44). Plating and polishing materials.

Lincoln Electric Co. (40). Arc welders and electrodes.

Lindberg Engineering Co. (68). Heat-treating furnaces.

Maas & Waldstein Co. (A-15). Lacquers and enamels.

MacDermid, Inc. (G-46). Plating and cleaning compounds.

Machinery Mfg. Co. (G-42). Machine tools.

Macklin Co. (274). Grinders and wheels.

Magnaflux Corp. (A-30). Magnetic inspection equipment.

Magnetic Analysis Corp. (A-12). Demagnetizing equipment.

Mahr Mfg. Co., Div. of Diamond Iron Works, Inc. (7). Heat-treating furnaces.

Malleable Iron Fittings Co. (298). Castings and pipe fittings.

P. R. Mallory & Co., Inc. (202). Nonferrous alloys, electrical contacts and welding electrodes.

Manganese Steel Forge Co. (D-21). Rolled, pressed and forged products.

Manhattan Rubber Mfg. Div. of Raybestos-Manhattan, Inc. (B-13). Abrasive cut-off machine and wheels.

Marburg Bros., Inc. (262). Jig borer and grinder, milling machine, filing machine, die setter and hand tapper.

The Matchless Metal Polish Co. (G-34). Polishing compounds.

Maurath, Inc. (D-31). Welding electrodes.

McKay Co. (E-38). Welding electrodes and chain.

McKenna Metals Co. (D-55). Carbide cutting tools, blanks, parts and boring tools.

Mears-Kane-Ofeldt, Inc. (S). Gas and oil fired boilers.

Metal & Thermit Corp. (F-26). Welding electrodes.

Metlab Co. (39). Heat-treating.

Midvale Co. (E-6). Extrusion liners and castings.

Milburn Co. (H-37). Skin protectors.

Minneapolis-Honeywell Regulator Co. (63). Instruments and controllers.

Molybdenum Corp. of America (E-42). Alloys and chemicals of molybdenum tungsten and boron.

D. A. Moreinis (B-46). Contour saws, files, polishers and surface grinder.

Morse Magneto Clock Co. (B-35). Watchmen's clocks.

Motch & Merryweather Machinery Co. (F-41). Metal sawing machines.

Multi-Hydromatic Welding Co. (A-6). Automatic welding equipment.

National Electric Welding Machine Co. (A-6). Electric welding equipment.

National Machine Works (N). Industrial gas apparatus.

National Time & Signal Corp. (B-63). Timing devices.

National Tube Co. (Stage). Seamless and welded tube products.

Nicholson File Co. (F-42). Files.

Norton Co. (290). Abrasive products and grinding wheels.

Oakite Products, Inc. (226). Cleaning compounds.

Ohio Carbon Co. (F-39). Burnishers, brushes and contacts.

Ohio Crankshaft Co. (264). Induction hardeners.

The Ohio Seamless Tube Co. (A-7). Seamless and electric welded steel tubing.

The Ohio Steel Foundry Co. (22). Heat and corrosion resisting alloys.

Tinius Olsen Testing Machine Co. (277). Testing, impact and dynamic balancing machines.

Ozalid Products Div., General Aniline & Film Corp. (H-26).

Packer Machine Co. (H-6). Polishing and buffing machines.

Page Steel & Wire Div., American Chain & Cable Co., Inc. (A-27). Welding wire and electrodes.

Pangborn Corp. (C-46). Blast cleaning and dust control equipment, cleaning barrel and table.

Park Chemical Co. (279). Polishing materials.

Parker Kalon Corp. (G-53). Screws and fasteners.

Partlow Corp. (F). Electric temperature control and recorders.

P. A. Patterson Co. (C-61). Tools and gages.

Penn Steel Castings Corp. (298). Castings.

Pennsylvania Electric Steel Castings Co. (298). Castings.

Philadelphia Electric Co. (E-58). Industrial power service.

Phillips Mfg Co. (266). Metal cleaning machines.

Physicists Research Co. (291). Profilometer for measuring surface roughness and internal tracer.

Porter-Cable Machine Co. (A-37). Electric saws, sanders and grinders.

Horace T. Potts Co. (250). Iron and steel products.

Progressive Welder Co. (A-6). Welding equipment, punching units and riviters.

Pulmosan Safety Equipment Corp. (H-35). Respirators.

Quigley Co., Inc. (H-30). Refractory brick.

Radium Chemical Co., Inc. (C-55). Radiographic testing equipment.

N. Ransohoff, Inc. (B-10). Metal cleaners.

Ransome Concrete Machinery Co. (B-17). Welding positioners.

Reading Steel Castings Div., American Chain & Cable Co., Inc. (298). Castings.

Reeves Pulley Co. (A-53). Variable speed transmissions, motor pulleys and motodrives.

Republic Steel Corp. (D-36). Alloy and stainless steel products.

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Revere Copper & Brass Co. (248). Copper, brass and bronze products.

J. E. Rhoads & Sons (A-57). Leather belting.

Riehle Testing Machine Div., American Machine & Metals, Inc. (D-29). Testing machines.

John A. Roebling's Sons Co. (H-16). Wire rope, shaped wire, insulated wire and cable.

R-S Products Corp. (D). Butterfly valves, gas heat-treating equipment.

Ruud Mfg. Co. (O). Water heaters.

Joseph T. Ryerson & Son, Inc. (G-17). Alloy steels and products.

Salem Engineering Co. (1). Industrial furnaces.

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A. Schrader's Son (B-51). Valves, gages and brass fittings.

Sciaky Corp. (242). Electric welding equipment.

Scully Steel Products Co. (Stage). Carbon and alloy steel flats, rounds, bars, rods, wire and shapes.

Selas Co. (E). Gas burners, furnaces, controllers and automatic flame hardening equipment.

Sellers Engineering Co. (R). Industrial gas equipment.

Sentry Co. (8). Heat-treating furnaces.

Sleeper & Hartley, Inc. (B-1). Coilers, spring machine and air vises.

S-M-S Corp. (A-6). Welding electrodes and special alloys.

Specialties Mfg. Co., Inc. (G-38). Stock reel and lathe attachments.

Spencer Turbine Co. (35). Low pressure fuel compressors and vacuum cleaner.

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Standard Pressed Steel Co. (A-58). Pressed steel products, cap screws and trucks.

Standard Steel Spring Co. (203). Corronizing compound.

Standard Steel Works (E-6). Castings and forgings.

Stoler & Curll, Inc. (A).

Stoody Co. (E-61). Hard-facing alloys, blast cleaning nozzles and wear resistant castings.

D. A. Stuart Oil Co. (C-1). Industrial oils and greases, cutting and grinding compounds.

Summerill Tubing Co. (H-29). Tubing.

Superior Tube Co. (H-46). Tubing.

Surface Combustion Corp. (J). Heat-treating furnaces, burners and accessories.

Swift Electric Welder Co. (A-6). Butt, spot and projection welders.

Synthane Corp. (G-35). Bakelite sheets, tubes, rods and fabricated parts.

C. J. Tagliabue Mfg. Co. (225). Industrial instruments and thermometers.

Taylor-Hall Welding Corp. (A-6). Pyrometers, thermometers, controllers and other instruments.

Taylor-Winfield Corp. (A-1 and A-6). Electric butt, spot and steam welders.

Tempil Corp. (28). Hardening and tempering pellets.

Tennessee Coal, Iron & Railroad Co. (Stage). High tensile and stainless steels.

Thomson-Gibb Electric Welding Co. (A-6). Spot, seam, flash and projection welders.

Tide Water Associated Oil Co. (292). Sulphurized and soluble cutting oils, industrial lubricating oils and greases.

Tinnerman Products, Inc. (45). Fastening devices.

Titanium Alloy Mfg. Co. (F-16). Titanium, ferro-alloys and refractories.

Treadwell Engineering Co. (298). Steel works equipment.

Harold E. Trent Co. (A-59). Industrial heating equipment.

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Una Welding Inc. (207). Portable automatic welding heads, portable tractor and welding transformer.

United States Steel Corp. (Stage). Alloy steels, high tensile steels and stainless steels.

Vulcan Iron Works (298). Hoists, engines and castings.

Wall-Colmonoy. (B-55). Hard facing alloys.

Welding Machines Mfg. Co. (A-6). Resistance welders.

Welding Sales & Engineering Co. (A-6). Automatic welding equipment.

Wells Mfg. Corp. (E-54). Bandsaws.

Westinghouse Electric & Mfg. Co. (E-1). Electric welder, controlled atmosphere brazing furnace, electric contactors and alloys.

Wheelco Instruments Co. (41). Controlling pyrometer, combustion safe-guards, excess temperature cut-outs, portable potentiometers, surface type pyrometers and indicating pyrometers.

S. B. Whistler & Sons, Inc. (G-50). Adjustable piercing dies and small die sets.

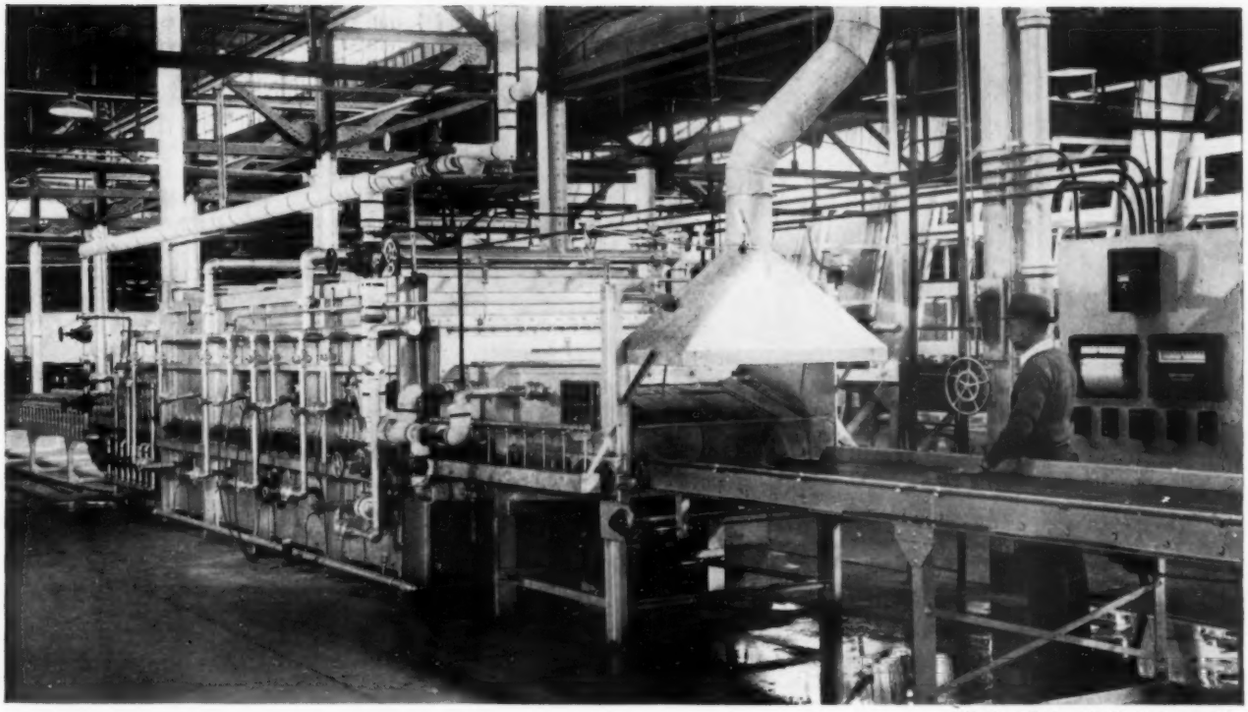
Wickwire Spencer Steel Co. (B-12). Metal conveyor belts, torsion, extension compression, coil, flat, motor and clock springs and wire forms; high and low carbon wires and wire cloths.

Lee Wilson Sales Corp. (F-6). Gas fired furnaces.

Wilson Mechanical Instrument Co. (53). Hardness testers.

Yale & Towne Mfg. Co. (C-6). Industrial trucks and material handling equipment.

Charles R. Yerger Co. (H-51). Die sawing and filing machines and drill jig bushings.



Courtesy Surface Combustion Corporation

A manufacturer of heating apparatus uses this roller-hearth furnace for bright-annealing of copper tubing. Water sprays cut down the length of the cooling chamber, are controlled so that residual heat dries the work without spotting before it reaches the atmosphere

Furnaces for Production Heat-Treating

BY RUPERT LEGRAND, DETROIT EDITOR, AMERICAN MACHINIST

1—Material handling has been added to the functions of many modern furnaces; they are often a part of the production line

FORTUNATELY for defense contractors and those who must renew their efforts to cut costs, time and rejections on non-defense material, production heat-treating furnaces are available in far greater variety than during the World War; in addition, modern furnaces have reached a high stage of development as machines. "Black magic" has disappeared in heat-treating and in its stead has come a thorough knowledge of the chemical reactions that take place with time, temperature and atmosphere. Today the chief responsibility of the furnace engineer is to provide the customer with equipment that has the greatest number of desirable and reliable features as a machine with due regard to the economics of the installation.

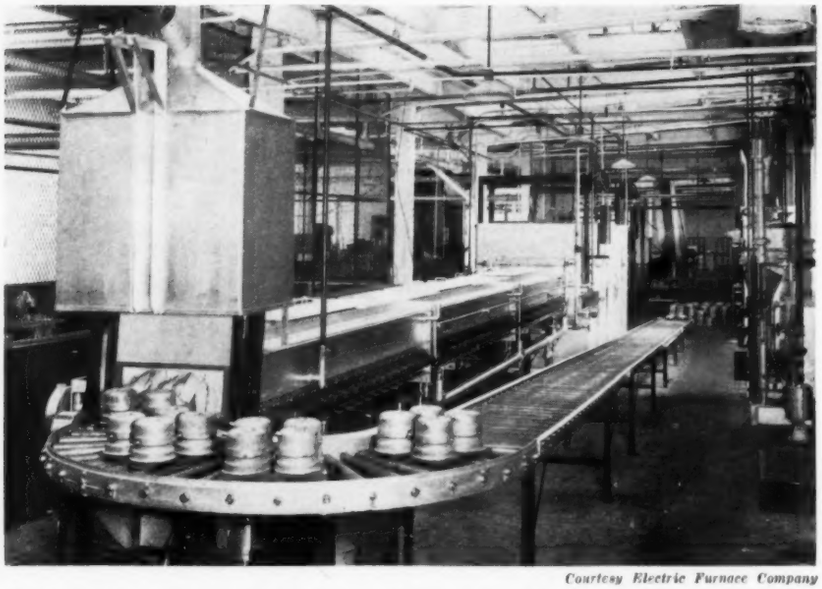
There are probably hundreds of different types of heat-treating furnaces for production purposes, if one counts in all the special designs of limited application. But the great bulk of furnaces fall into relatively few categories. Some of these are of comparatively recent development, either as types or as practical commercial designs. In selecting a furnace, an open-minded approach is just as essential as with other types of production equipment. To aid in this direction, the several types of furnaces are discussed as machines from the standpoint of advantages and disadvantages, work-handling methods, work speeds and loadings, and fields of application by material and process.

For assistance in preparing this article, acknowledgement is made to the following concerns: American Gas Furnace Company, Electric Furnace Company, Gas Machinery Company, General Electric Company, Holcroft & Company, Surface Combustion Corporation and Westinghouse Electric & Mfg. Company.

ROLLER-HEARTH FURNACES

Mass-production heat-treating on a tonnage basis is the field of the roller-hearth furnace. Steel and non-ferrous mills employ roller-hearth furnaces in large numbers for annealing and normalizing sheet, tubing, bars, wire and extruded sections, while mass-production fabricators use them for conditioning material received from mills as well as hardening and annealing. A growing application is that of brazing assemblies too heavy for belt furnaces.

The roller-hearth furnace is limited in charging width and unit loading as compared to the walking-beam type. As a practical matter, however, industry has concentrated its attention on the roller-hearth furnace for tonnage out-

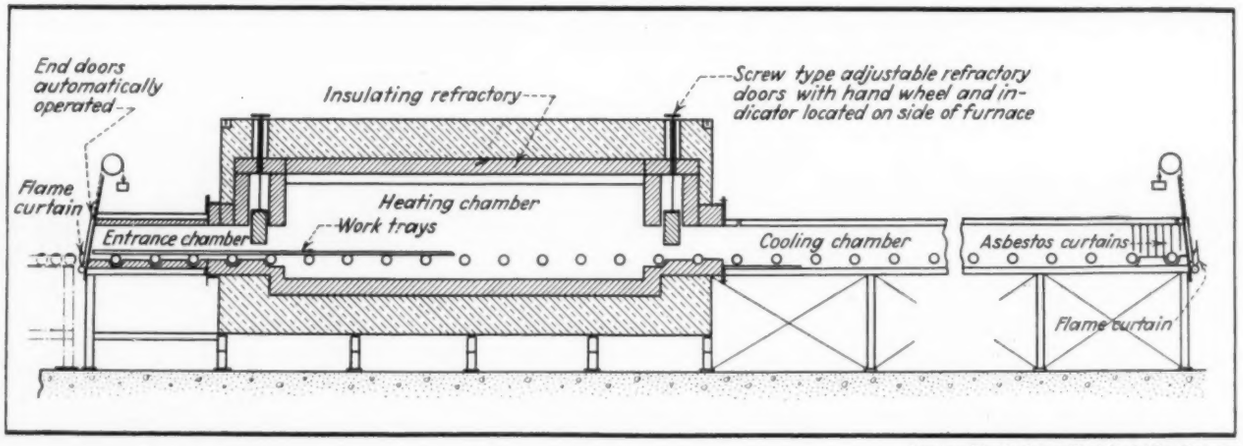


Courtesy Electric Furnace Company

Refrigerator-compressor units are shown emerging from the long cooling section of a roller-hearth copper-brazing furnace. Labor is conserved by the gravity conveyor that takes brazed assemblies back to the furnace operator for stacking in skid boxes

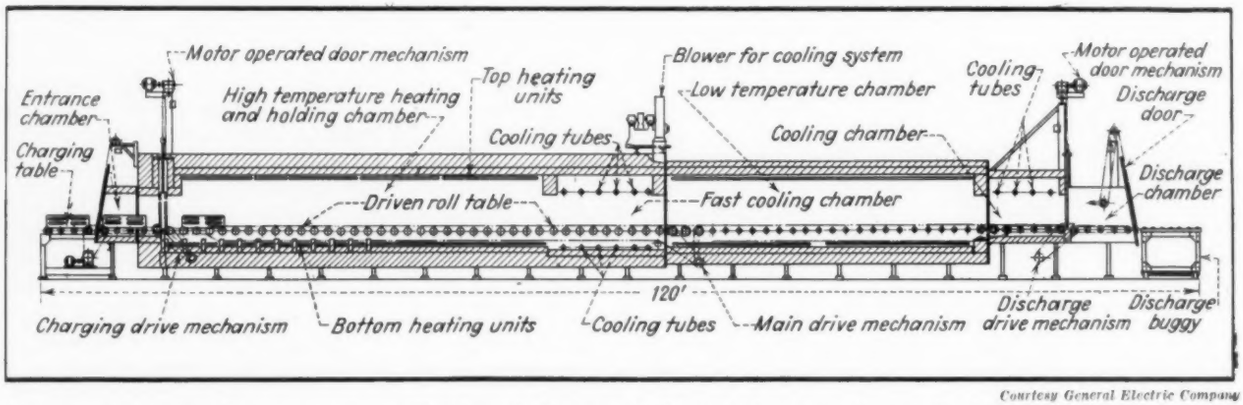
put. Work movement is accomplished in two ways: (1) directly by friction with the power-driven hearth rolls, or (2) by loading the work into trays, baskets, boxes, or special containers resting on the hearth rolls. Direct contact with the rollers is permissable for sheet, tubing, extruded sections and fabricated articles that will ride endwise through the furnace without jamming. Fabricated articles and parts of such size or shape that they will jam in the rollers must be carried in containers, likewise assemblies to be copper brazed.

Modern roller-hearth furnaces frequently involve the use of protective atmospheres. Bright annealing, bright normalizing and copper brazing all require extended cooling zones in which the work is protected from oxidation by a chamber filled with gas. In addition, curtained entrance and exit zones to keep air from entering the furnace, purging zones to eliminate air adhering to the work, plus entrance and exit roller sections add to the length of roller-hearth furnaces. It is not uncom-



Courtesy Westinghouse Electric & Mfg. Company

As mass-production heat-treating machines, roller-hearth furnaces are commonly designed for a specific job, and the heating and cooling sections proportioned to the requirements of the cycle. Work that will not jam in the power-driven hearth rollers is transported by direct contact with them; otherwise it is loaded on trays



Courtesy General Electric Company

An auto-parts manufacturer uses a roller-hearth furnace of this type for annealing malleable-iron parts in an automatically controlled time-temperature cycle

mon to find that the over-all length of the installation is three to four times the heating chamber length. Furnace length is primarily related to production requirements and thickness of parts being heated. For annealing purposes, heating chambers run from 20–30 ft. long on the average, but sometimes reach 50 ft., with over-all length up to 170 ft. Copper brazing furnaces have shorter heating zones because the higher process temperature permits a faster rate of work movement compared with annealing and normalizing processes, but since the cooling zone must be relatively much longer (work must be cooled from 2,050 F., as compared with 1,350–1,400 F. for annealing and 1,750 F. for normalizing) it is not uncommon for brazing furnaces to reach an over-all length of 100 ft.

Work speeds vary with the work dimensions and process. From 100–200 ft. per min. is common in annealing thin sections. For heavier work carried on trays, the speed drops to 1 to 5 ft. per min. And for copper brazing, speeds of ½ to 2 ft. per min. are found suitable.

In roller-hearth furnaces, the charging width is limited by the unit loading per sq. ft. of projected hearth area and the process temperature. Alloy rolls rapidly lose strength with temperature rise. Thus, for annealing at 1,350 F. the effective roll length seldom exceeds 7–8 ft., and commonly lies between 4–5 ft. Unit loadings vary widely, but seldom exceed 100 lb. per sq. ft. of hearth area, depending on furnace temperature. But at brazing temperatures of 2,050 F. the alloy rolls lose strength so rapidly that maximum charging widths are decreased to say 24 in. and unit loading to 25-35 lb. per sq. ft. of projected hearth area. Often, the rolls must be 5 in. in diameter and spaced at 10-in. centers, which represents the maximum roll diameter and closest spacing permissible with conventional journal designs.

Roller-hearth furnaces are intended for operation continuously on a three-shift basis for a month or more before being shut down for inspection or repair. Over week-ends they are allowed to float at lower than process temperature, but are reset to operating temperatures by the maintenance force an hour or so before the new work-week commences.

Operating labor is comparatively small per unit of output, but depends in large measure upon the adequacy of charging and unloading equipment, and with the opportunity afforded the furnace engineer to tie the installation into the production scheme. In brazing furnaces, for example, the operators are required to assemble the components anyway and loading is merely a detail. If the installation warrants, a gravity roller conveyor can be run along the furnace from the discharge end to return unloaded trays. Loaded trays can be shoved to a section of power-driven rolls before the furnace entrance. As the tray moves toward the door it can be arranged to strike a limit switch that raises the door, the tray then being picked up by a section of fast-operating rolls and rapidly moved into the furnace. The door is quickly closed by a timing mechanism.

In laying out a roller-hearth furnace installation, room must be left to withdraw rolls from the furnace side wall during maintenance operations. If two furnaces are installed side by side, one center aisle will serve both furnaces.

PUSHER FURNACES

Pusher furnaces are widely used in production heat-treating of: (1) work that cannot be conveyed suitably through walking beam or roller hearth furnaces, (2) work in which unit loadings and dimensions are not suitable for belt furnaces, and (3) for plants in which a wide variety of parts are best handled by the tray system.

Although pusher furnaces are perhaps most widely known for their use in steel mills for slab heating furnaces, many large, medium and small-size installations are being made or have recently been made in the metal-working industry for annealing coiled wire, tubing and brass shell cases, also hardening, annealing and copper brazing of miscellaneous castings, forgings and machined assemblies that are too large or heavy for a belt furnace, and which cannot be conveniently processed in roller-hearth furnaces.

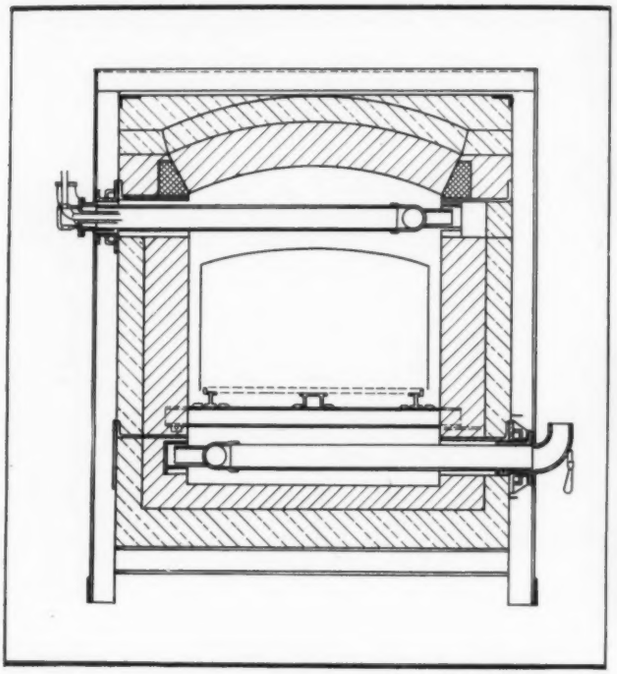
The work is usually carried in trays, but often special racks are provided. In the latter case the racks may be fitted with a bulkhead at the end to act as a sealing member when leaving the furnace. Bulkhead construction prevents loss of protective atmosphere, also prevents air from entering the furnace, and is a new development for furnaces having a comparatively large chamber cross-section.

Trays can be shoved manually through small pusher furnaces, or a foot-operated pusher can be applied. Larger installations require a power cylinder or other feeding device to move the trays progressively toward the rear of the furnace. Opening of the doors and action of the pushing mechanism can be controlled by electric eye or other automatic means.

Pusher furnaces are available in such

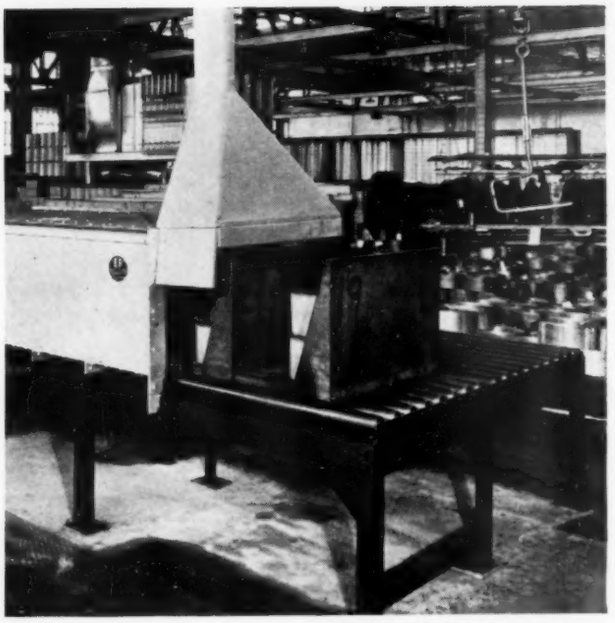
Courtesy Holcroft & Company

Fifteen automobile parts of various sizes are casehardened through the flexibility of the pushing cycle of this 1,500-lb. per hour furnace. As shown, the operator at the charging end of the furnace merely pushes two trays into the vestibule. In a timed cycle, double doors at both ends of the furnace are closed and opened, the new charge is pushed into the furnace, and a pair of trays is quenched—all mechanical movements being interlocked by the electric timing equipment



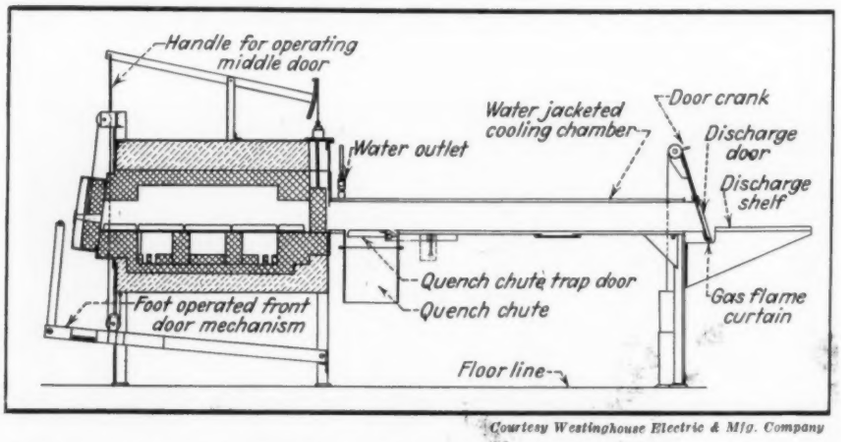
Courtesy of Holcroft & Company

Two rows of trays are kept in alignment by lips on the two outside rails. Each 12x18-in. tray carries an average load of 40 pounds and holds a loose charge of small parts or racked pieces on an alloy grid



Courtesy of Electric Furnace Company

Bulkhead trays are used with pusher furnaces of large cross-sectional area to prevent excessive loss of protective atmosphere from the cooling chamber and to avoid ingress of air. The grid-like bottom of the bulkhead trays provides a suitable surface for coils of wire or tubing, large castings, or for stacked boxes



Courtesy Westinghouse Electric & Mfg. Company

Small pusher-type furnaces may be designed to accomplish several types of heat-treating operations, so that the user can process various parts in trays upon a limited production or experimental basis. This equipment, which may range from 12–20 ft. in length, is built primarily for copper brazing, but is also adaptable to bright annealing and bright normalizing when the cooling section is utilized, and for hardening by using hanging-type false bottom trays to dump the work

small sizes as 12 ft. long including heating and cooling zones. While intended for experimental work and low production of comparatively small parts, furnaces in this size range offer the small shop the advantages of a production set-up in which handling is minimized. More common production sizes range from 20–100 ft. in length, but greater lengths are not uncommon.

Pusher-type furnaces can be used to heat-treat a number of parts on a mass-production basis. At the Buick Motor Car Company, fifteen parts ranging from brake pedal pins to flywheel ring gears are being light casehardened in a two-row pusher furnace with an inside length of 27½ ft. and rated at 1,500 lb. per hr. Two rows of trays ride side by side on alloy steel rails. Trays are of special design, made to hold either a loose charge of small parts or a racked charge in an alloy grid placed over the tray. A vestibule at the charging end prevents air from diluting the atmosphere within the furnace. An outer door is opened, two trays are placed on rails in the vestibule, the door closed and an inner door opened, following which the pusher mechanism moves the two lines of trays ahead one position. The pushing cycle can be varied from 3 to 7 in. Double doors are also provided at the discharge end. As two trays emerge into the discharge vestibule, a set of arms pulls them onto an elevator, which lowers them into the oil quench. An inclined conveyor moves the trays up and out of the quench to the unloading position. Operation of the pushing mechanism and the elevator are under control of electric time clocks, with the entire system interconnected. In this case two operators are required, one for loading and the other for unloading.

For furnaces intended for annealing large tonnages of castings, or other products, the recuperative principle is employed. Cold work enters the furnace on one path, is pushed to the rear of the furnace and there transferred mechanically to the return patch. Cold work is thus preheated by heat given up by annealed work. About 30 per cent of the heat required in the annealing process is saved by the use of the recuperative principle.

Part 2 of this article will appear in an early number.

Analyze Jobs for Better Welds

BY R. A. GAST, THE LINCOLN ELECTRIC COMPANY

Greatest benefit is obtained from welding when design meets service requirements fully, and when equipment and procedure permits low cost production

OBTAINING MAXIMUM advantage, from any production tool, or process, obviously is not just a matter of employing the tool or process. Simply using the equipment, of course, allows it to perform the work for which it is intended. However, if it is to perform with greatest efficiency and economy, all factors which bear on the question should receive careful attention. When a check-up is made, surprising results, in the form of faster production and lower costs, are frequently produced. In any event, it is never wise to let affairs continue in the same groove, indifferent to possibilities of improvement. This is particularly true of welding.

Many companies, which have been impressed with the initial economies and production speed permitted with welding, have been surprised at the further advantages brought about by

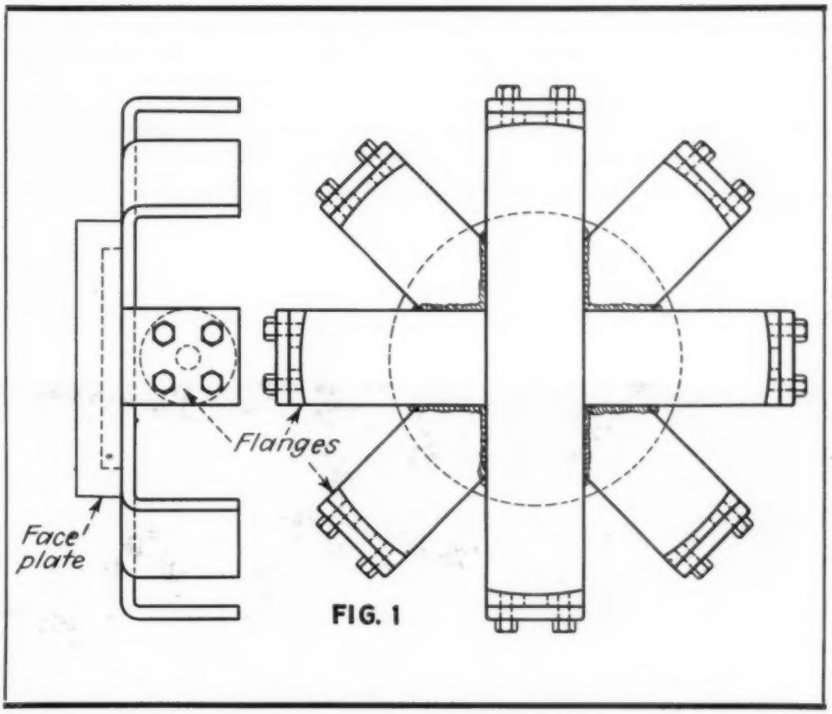


Fig. 1—Flanges for a welded steel cylinder easily were machined to fit the cylinder wall with this welded fixture designed for mounting on the face-plate of a lathe. Flange faces were bored to 18-in. diameter for a leakproof fit without gaskets

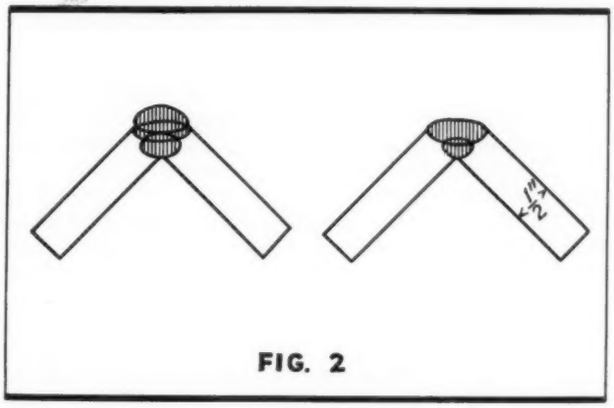


Fig. 2—Welding speed was increased 30 percent and grinding time reduced two-thirds by changing electrodes and procedure when welding the base of a broaching machine. Two passes now are used instead of three. Formerly the entire bead had to be ground; now only the sides of the weld are touched up with a hand grinder. The sketch at the left shows the weld before grinding under the former procedure while the sketch at the right shows present practice

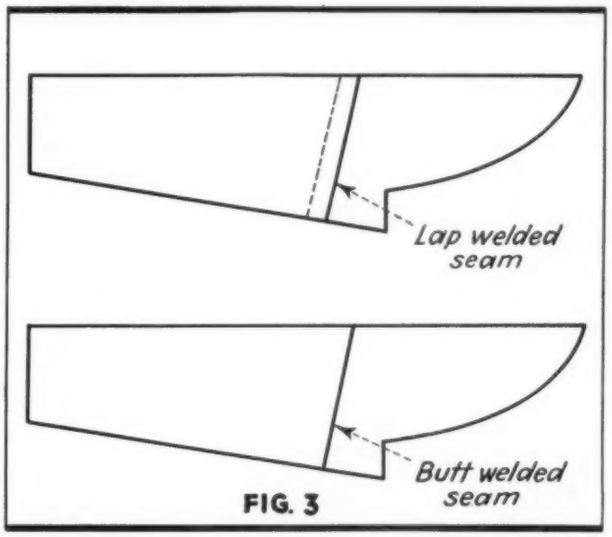


Fig. 3—Change of design to permit butt welding instead of lap welding reduced welding time from 8 hr. to 2 hr., when altering an automobile body and saved 20 to 30 man-hours finishing time

a careful study of factors, such as design, welding equipment and procedure, which greatly affect production speed and costs.

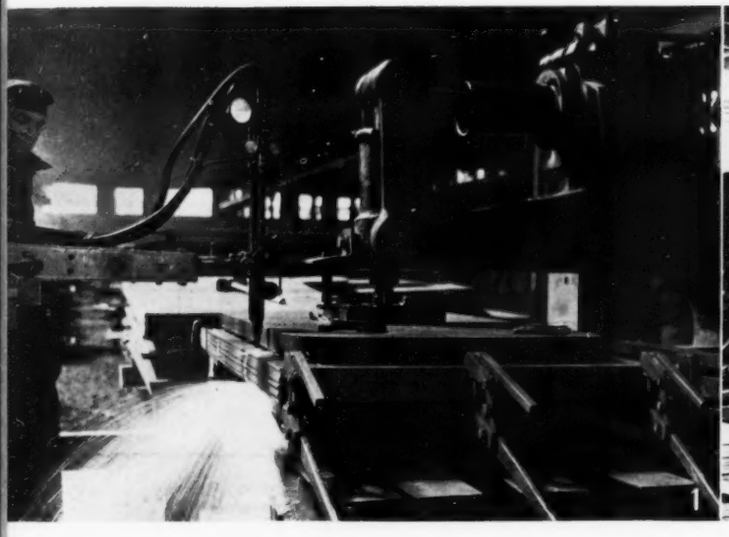
One example is illustrated in Fig. 1. This special jig indicates what a study of welding as applied to construction of jigs and fixtures can mean in production. By furnishing the means for holding eight flanges during machining operations, this jig enabled a company to put an idle lathe into operation and to greatly improve production. Moreover, the jig saved time and labor through easy assembly, and also provided a leakproof fit without gaskets, while improving appearance.

The flanges are machined to fit the outside wall of a cylinder used in a ship under construction for National Defense. They are approximately $\frac{3}{4}$ in. thick before machining. Two bolts hold each flange in the jig during the boring operation. The cylinder to which these flanges are electrically welded is 24 in. long, 18 in. in diameter and $\frac{5}{16}$ in. thick. The accurate machining accomplished provides a perfect fit of the flanges to the cylinder so that the structure is entirely leak-proof after welding is completed.

A second example of the benefits resulting from careful study of welding operations is the welding of corners in the base of a broaching machine by a leading machine tool builder. In this instance, changing from one type of electrode to another designed especially for the particular application increased welding speed by 30 per cent and reduced grinding 66⅔ per cent.

Formerly, the corner of the base was welded in three passes, the first pass with $\frac{1}{4}$-in. electrodes and the second and third with $\frac{5}{16}$ in., weaving the last bead to provide a rounded corner, as at the left in Fig. 2. This procedure produced a high bead, a large portion of which had to be ground off to obtain desired finished appearance. It required 45 min. grinding to finish the

Flame-Cut



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DOORS FOR railway hopper and gondola cars are fabricated by the Standard Railway Equipment Mfg. Company. As forming and flanging are done simultaneously, it is essential that blanks be accurate to avoid later trimming or filling. Quantities are often small, so pantographic oxy-acetylene pack-cutting of the blanks appeared to be economical, providing that a method of clamping the plates tightly could be developed to prevent burn-together. Edge-clamping allowed center bulging along the line of the cut; center clamping alone failed because shearing burrs on the dozen or so $\frac{1}{4}$x48x48-in. plates in an economical pack caused them to stand apart when stacked.

1. Original suggestions were for hydraulic clamps for each of the cutting units at a cost of $3,500 each. Instead, W. J. Tangerman, plant superintendent, developed pneumatic clamps at a cost of $250 each, plus a little labor. He bought two old Allen bull riveters and converted them as shown. The upper die is replaced with a 2-in. thick steel plate and a $\frac{1}{2}$-in. square welded all around its edges to apply the pressure as near the kerf as possible. A similar plate is supported on the I-beam frame below, so that the lower die rests against it when the riveter is in position. (Note that I-beams carry slides with supporting pins to prevent beam burning). Upper-plate position can be adjusted by the usual riveter adjusting screw. The pack is located against a backstop supported by the table, and the riveter itself can be rolled back out of the way on four wheels resting on a short narrow-gage track. Auxiliary toggle clamps, hand-operated and with coil springs to separate the jaws when open, are used only when the plates have badly sheared edges. Here the cut is just being started.

2. Ten $\frac{5}{16}$- or twelve $\frac{1}{4}$-in. plates form the pack; plate size ranges from 36 x 42 in. for hopper-car door blanks to 48- up to 56-in. squares for gondola-car door blanks. Clamping pressure is about 50 tons with 100-lb. air pressure. Here the clamp has been opened after a two-part cut has been completed. Note the gage at the throat of the clamp and the right-angle entrance line of each cut. This is advisable to prevent torch blow-outs and consequent necessity of welding up gouges in plates after fabrication is completed. Many blanks are cut from just outside the clamp throat on one side all the way around to the other, the square sheared edge within

job, in addition to the extra time for weaving the third bead.

Now, by use of the new electrode adopted as a result of the study, the welding is done in two passes instead of three and the second bead is rounded with only slight build-up. This eliminated 30 min. grinding time. It is now necessary only to touch up the sides of the weld whereas formerly they had to grind the entire bead. Fig. 2 (left) shows the weld before grinding under the former procedure.

The third example has to do with the use of welding in making alterations in a standard automobile passenger car body to adopt it for special service. This job required lengthening the hood cover and the side panels between hood cover and front fenders. This is accomplished by setting the windshield back about 6 in. and welding an extension in place as in Fig. 3. Change in welding procedure now enable completion of a job in 6 hr. as against 18 to 24 hr. for the former method. The welding time under the new procedure is 2 hr. as compared with the former 8 hr.

The former procedure involved the use of lap welds, because with the process employed a straight butt weld would cause excessive warpage. The pieces of metal were lapped, spot welded in place and then finish welded on one side. Because of the holes and uneven surfaces caused by the distortion of welding, solder was applied. To obtain a smooth surface it was necessary to shape the soldered area with hand rasps and grinding disks, finally finishing the job with emery.

Present procedure is to simply weld the 20-gage, 6-in. strip directly in position between the hood cover and windshield, also into the body side panel, by means of plain butt joints, as in the lower sketch in Fig. 3. Actual savings reported include 20 to 30 man-hours finishing time and approximately 10 lb. of solder per job.

Hopper Doors

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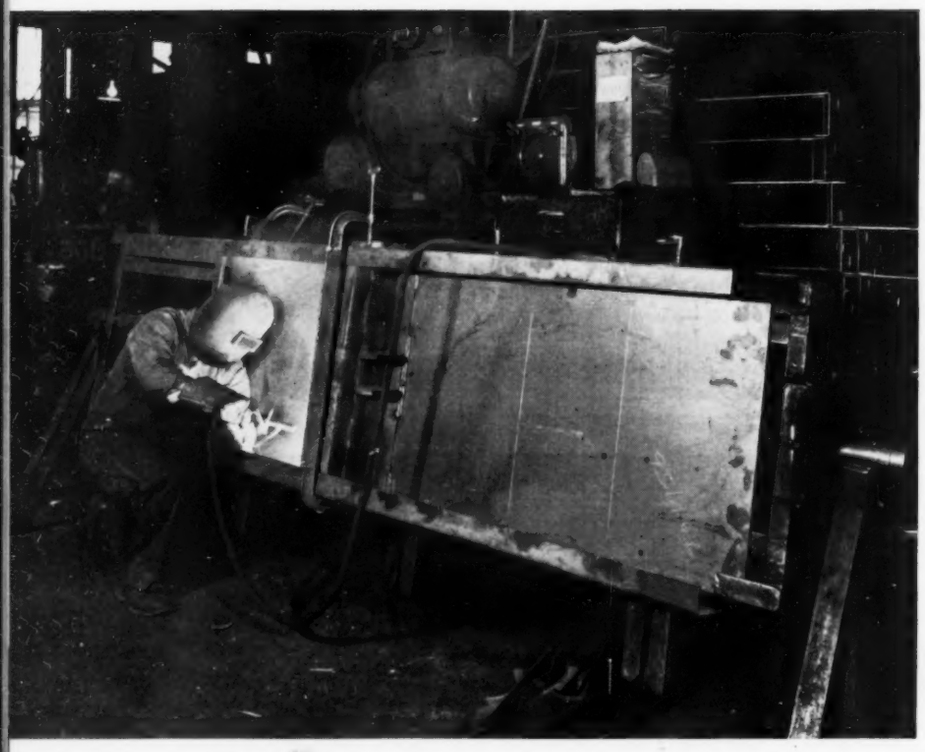
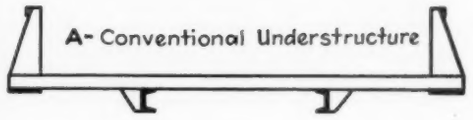
the throat being left for press gaging and in the final door being the portion between the hinges. When a straight front side is required longer than about 2 ft., as in this case, it is more economical to shear this edge. Torch cutting speed is 10¼ in. per min., giving a production of about 200 plates per cutting unit per 8-hr. shift, with an operator and a helper.

3. Here the riveter has been rolled back out of the way to permit crane hoisting of the shape-cut pack and placing of a new pack. Note the carriage and track at lower left. The finished pack has here been placed on an all-welded "unpacking" fixture, consisting of an angle-iron frame carrying pipe rollers on its upper surface and one inclined face with a stop at its bottom. The pack is simply pushed off the end of the fixture on the inclined side and drops down to separate into its component plates, as shown in the next picture. When cuts are made all around the blanks, the C-shaped scrap is knocked down to catch on the hooks at the right before the stack is unpacked. The smoothness of the edges can be preserved regardless of blank shape; hinge clearances and other irregular edge openings are commonly cut as readily as is a straight section. Two Linde 100-in. pantographs are used for the cutting, each equipped with the new high-speed narrow-kerf nozzle. These have stepped cutting speed up from 6½ to 10¼ in. per min., without noticeable loss of edge smoothness.

4. The stack is now "unpacked" and ready for the crane to take it to the forming press. Note the rollers on top of the "unpacking" fixture and the rear of the riveter truck. This method is economical for production runs up to 3,000 sheets, above which blanking dies become more economical. Die cost is normally about $500 for blanking knives, plus the costs of bolsters if needed and, of course, the necessary shearing equipment. Further, the shape-cutting process permits necessary "cut-and-try" experiments by following a drawing with the pantograph tracer wheel. Then, as soon as the desired blank shape has been obtained, the cutting templet can be made in about 2 hr., permitting both the press and the pantograph to be kept on the same job, and not requiring press-die changes while the two weeks required for making the blanking-knife elapse. Photographs here were taken by Frank Phillips, chief die designer at the plant.





At A *in the above sketch is shown the understructure for a dump truck body of conventional design. The pressed steel trussed understructure shown at* B *is formed from steel sheet sections that are joined by spot and arc welding to form a rigid assembly*

While most of the body assembly is joined by spot welding, the heavy "push" member, to which the hydraulic hoist is connected, is arc welded to the center section of the body. Trunion supports for the fixture swing the assembly to suit the operator

Spot Welding Truck Bodies

BY HERBERT CHASE

Special welding fixtures of simple design help speed the production of a new Gar Wood dump truck body. These fixtures have casters to permit moving

FABRICATION of all-steel truck bodies on a large scale is well organized in one of the Detroit plants of Gar Wood Industries, Incorporated. Although this applies to many of the numerous types produced, manufacture is most highly developed in certain types of dump bodies which are turned out in largest quantities. The major fabricating operations on one of the latest designs of hydraulically operated dump body are accomplished largely by spot welding, although some arc welding is also done. The whole procedure is simplified by a new design, which results in an exceedingly sturdy product.

Practically all the elements entering into the assembly are parts with flanges at right angles to the major surface. For this reason, they are rapidly and economically formed on brakes. As assembly is by welding, it is not necessary to punch rivet holes. Subsequent to forming, the parts are banked near the assembly line where they are handy to those who perform assembly operations.

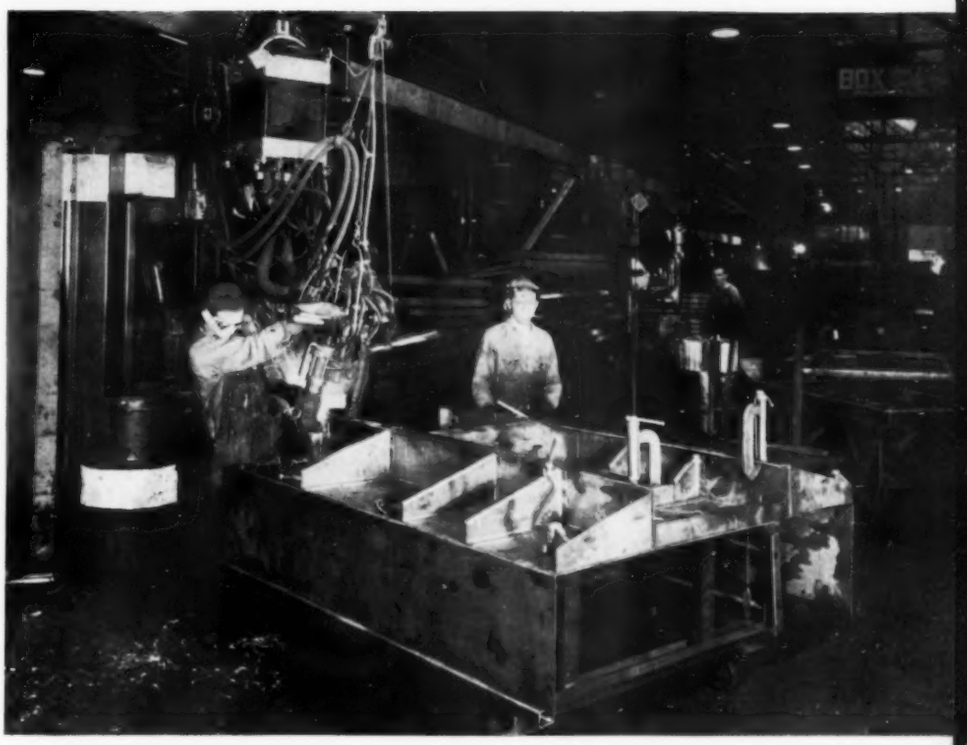
Most of the assembly is done on benches or in special holders, some of which are arranged on trunions so that they can be rocked through an angle or inverted to bring the work into convenient position for the welding operations. Much of the welding is done by "guns" supported by chains from above or carried on double-hinged brackets. The welding equipment is provided with air operated clamping devices which insure proper contact between the surfaces to be welded.

One of the first assembly operations is on a side unit which is placed on a trunioned table. Supports for the trunions are carried on an angle-iron frame which is mounted on casters, thus making it easy to move the table, along with the work which it supports, and to bring the points to be spot welded between the electrodes of the spot welding machine employed. After spot welding the outriggers to the under side of the floor portion of the unit, the latter is rocked through a 90-deg. arc and is then in position for spot welding the stiffening braces to the outside of the body. Both the right- and left-hand units of the body are fabricated in this manner.

To insure a rigid support for the cross member which carries the pivot to which the hydraulic hoist is later attached, this cross member is arc welded to the central section after the pivot support has been arc welded to the member itself. This operation is performed while the center section of the body is supported on a trunioned table so that the unit can be turned into various positions to effect the welding with greatest convenience. When the arc welding is completed,

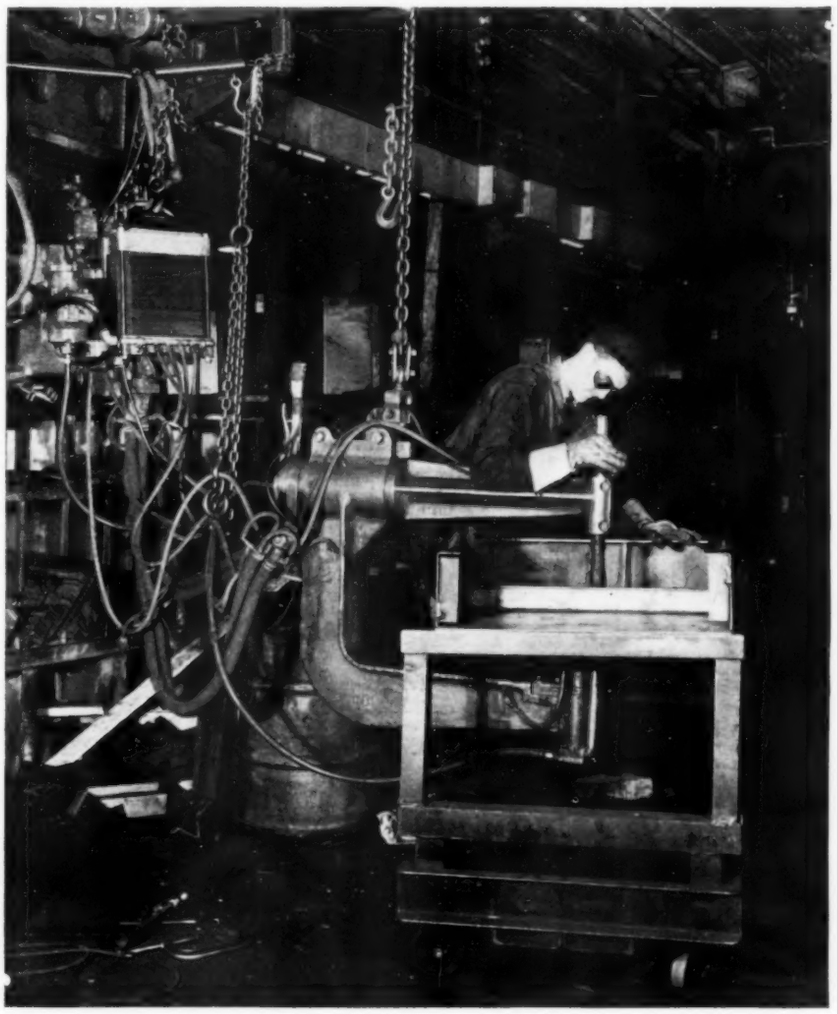
the center section is transferred to another table where a gun welder is used to spot weld the remaining transverse stiffening units in place. This operation completes the third major subassembly of the body and the three major units are ready for joining into what becomes, in succeeding operations, the final assembly.

To make the spot welds which join the center and side sections at their vertical flanges, these sections are placed, bottom up, on a low bench supported on casters which make it easy to move the work from weld to weld as the work progresses. This minimizes the work required to bring the heavy welding gun into the required positions. A large number of welds are made in fastening the two pairs of vertical flanges together after they are placed in correct relative position. The welds make the vertical flanges virtually one piece and the double thickness of metal provides a longitudinal seam of great strength and one which is stiff in all directions. While still on this table, the shaft and fittings for operating the tail gate are set in position and the supporting brackets are welded to the under side of the body. Finally, a front panel is applied and the gun welder is used to spot weld it to the front ends of the three major units, which already are welded together.



A large welding fixture mounted on casters supports the main body assembly and the two side subassemblies while these three units are joined by spot-welding corresponding vertical flanges

Transverse stiffening members are spot welded to the channel-like center section of the body on this movable fixture. This illustration shows details of one of the gun-type welders, which is in position ready for use



This virtually completes the body proper except that supports for the tail gate are arc welded in place and a few minor joints not spot welded are made by arc welding. The tail gate constitutes a separate subassembly which is merely hinged to the body proper.

When thus completed, the body is lifted by an overhead crane and is carried to a pickling tank to remove weld flash, scale and grease. The body then is given a thorough wash in hot water and, when dry, is ready for spray painting.

Minimizing Distortion

COMPILED BY J. G. MAGRATH, APPLIED ENGINEERING DIVISION, AIR REDUCTION COMPANY

For many flame-hardening jobs distortion is negligible; for others it can be controlled by the expedients described below

THE AMOUNT of distortion encountered in flame hardening is generally well within manufacturing tolerances. Since it is primarily a localized surface processing method, less distortion results than when the entire object is heated and quenched.

Two effects must be considered with reference to distortion. Where the surface of a massive object is progressively heated, an upsetting of the heated zone surrounded by a confining cold mass results. This shortens the side of the object heated tending to distort it concavely.[4] The second effect is the change in phase of the hardened volume from pearlite to martensite which tends to lengthen the surface heated. In addition, most materials have casting or rolling strains, some of which may be released upon heating. Thus there is no general rule for predetermining the extent of distortion. Where parts are to be held to a fine tolerance it is generally recommended that they be fully annealed before hardening to remove existing strains.

Other Factors Have Effect

To a minor degree the extent of distortion may be affected by: (a) material used, (b) thickness of material, (c) hardness depth, (d) rate of quench, (e) and design of part. This last item, the design of the part, should be given ample consideration to permit flame hardening under the best conditions.[6]

Distortion may occur when one surface of a thin flat object is heated and quenched. The object tends to curl on the hardened side, with a distortion of from 0.002 to 0.005 in. per foot of length in sections under 2 in. in thickness. See Fig. 16 *a*. This distortion may frequently be compensated for by prebending in the reverse direction before flame hardening,[3] as shown in Fig. 16 *b* or it may be reduced by partially immersing the object in circulating water as indicated in Fig. 16 *c*. Thin sections require greater care than thick ones. With thicker sections, the restraining effect of the cold core metal minimizes distortional effects.

The higher the surface temperature, the deeper the hardened layer and the greater the hardening stresses, which when sufficiently large, tend to produce distortion. Therefore, in order to restrain hardening stresses from distorting the part, the minimum depth of penetration to suit the requirements and the minimum heat to produce this penetration should be employed.[14]

In the case of circular sections, or where both sides of a flat object are flame hardened simultaneously, as is done with gear teeth, distortion is practically nil.[3] Distortion is rarely a factor in band or progressive spinning of

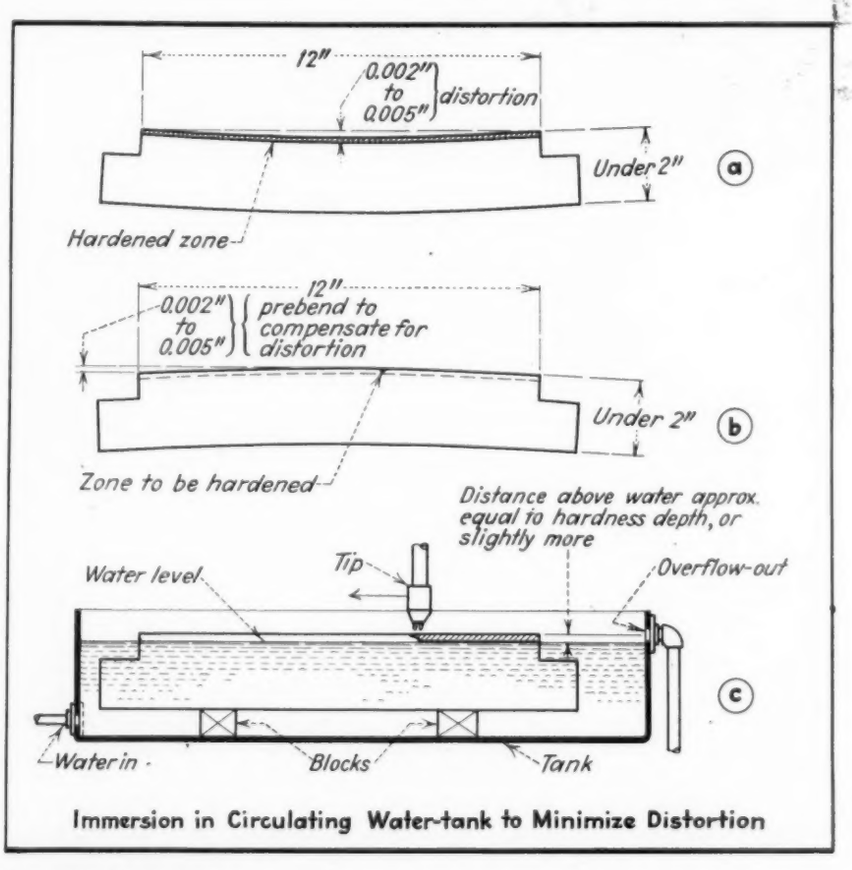
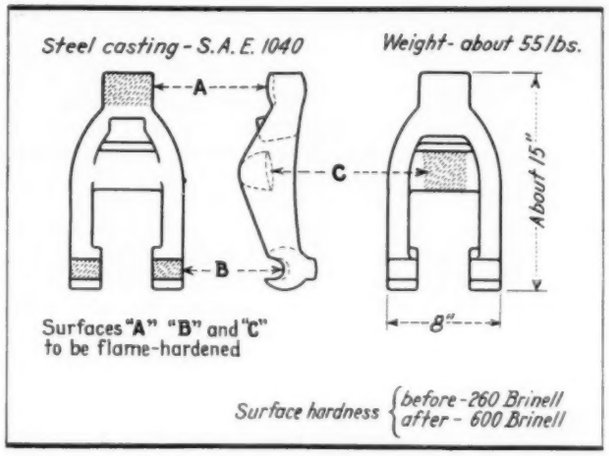
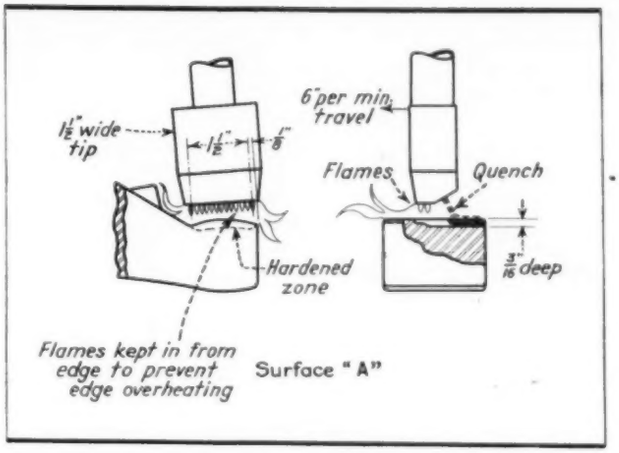


Fig. 16—When flat parts *tend to curl under hardening as at* A *they may be prebent* B *or immersed* C *to offset the distortion*

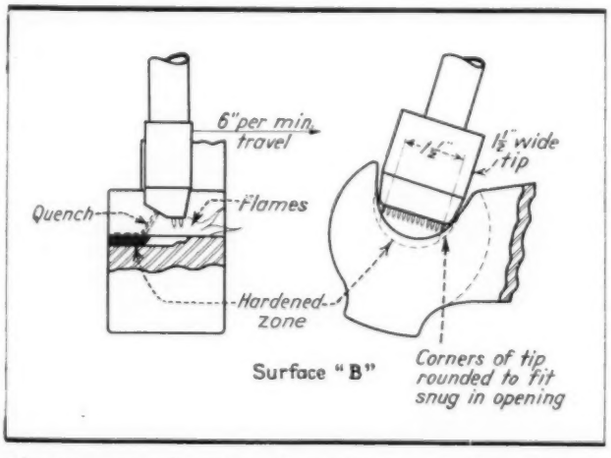
Cast steel SAE 4145 *car retarding floating levers are successfully flame hardened on several irregular surfaces by a manufacturer of railway signal equipment. The way in which the work is set up is illustrated at the right, while the method of procedure is graphically shown below*



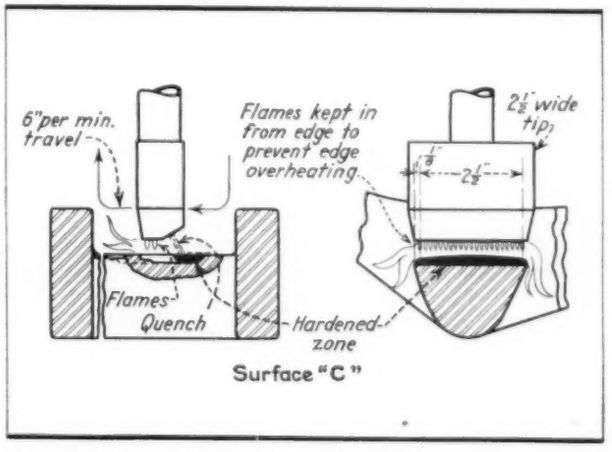
The hardened areas *must be properly entered at the points of greatest pressure. Surfaces to be flame hardened are indicated*



First the end surface *A is hardened with the levers nested horizontally and a traveling radiagraph passing across them*



Next comes surface *B on the opposite end. For all steps in hardening the integral heating and quenching tip travels at about 6 in. per min.*



The third pass *takes surface* **C.** *With a water quench the severity of the quench caused surface checks. A soluble oil has been substituted with satisfactory results*

rounds and in hardening small areas of large objects.[4] It is encountered largely when flame hardening single surfaces of extensive areas such as ways of machine tools. However, where it is possible to rough machine a part, then flame harden and finally finish grind, the small amount of distortion, sometimes experienced, is of no hindrance.

Some alloys tend to reduce distortion. Molybdenum intensifies the hardening effect of other present alloying elements and contributes to deep hardening depth. Therefore, with molybdenum present, depths, that in plain carbon steels might require large volume heat input, may be secured with less heat and less danger of distortion. For appreciably the same depth of hardness, the alloy cast irons tend to show less distortion than the plain cast irons.[14]

May Be Minimized

When distortion does occur it can be reduced by a stress relief draw (tempering). Distortion on test specimens was reduced 25 to 40 percent with only 2 to 5 points (R_a) decrease in the hardness in a stress-relief draw at 300 F. for seven hours.[14] On 50 in. outside diameter forged 0.43 percent carbon steel gears, which were raised from 180 to 500 Brinell on the teeth faces, eight center marks were made diametrically opposite on the sides of the rings. The maximum distortion was found to be 0.004 in. in 50 in.[17]

Normalizing or annealing, to equalize stresses, generally should precede flame hardening wherever possible, especially on cast iron and forged or cast steels.[5,6] Where parts have been previously hardened, or have been in operation, they should be annealed before flame hardening, otherwise checking may occur because of rapidly heating work-hardened areas.

Careful consideration should be given to the procedure of stress relieving employed.

Annealing is the heating and cooling of metal in the solid state. It usually implies a relatively slow cooling. Its purpose may be to remove stresses; to induce softness; to alter ductility, toughness or other physicals; to refine crystalline structure; to remove gases; or to produce a definite microstructure. A full anneal is generally about 100 F. above the upper limit of the critical temperature range, for not less than one hour for each inch of section of the heaviest objects being treated. The part, or parts, are allowed to cool slowly in the furnace, or are removed and cooled in a medium which prolongs time of cooling as compared to unrestricted cooling in the air as is done in normalizing.

Process annealing is heating the iron base alloys to a temperature below or close to the lower limit of the critical temperature range, followed by cooling as desired.

Stress Relieving

Normalizing is the heating of the iron base alloys to approximately 100 F. above the critical temperature range; followed by cooling fairly rapidly to below that range in still air at ordinary temperature.

The choice of either annealing or normalizing is one that must be made by the heat-treater, foundryman or metallurgist, as a full knowledge of the metal employed, as well as the procedure of manufacture and future use to which the part is put, will contribute to such decision.

The internal stresses set up by the quench-hardening process, either after the brief, sharp oxyacetylene flame or after furnace heating, are difficult, or even impossible, to estimate. When the flame hardening process is properly employed, the internal stresses are likely to be less than those after furnace-heating due to the relatively thin surface layer heated above the transformation range. This layer is backed up by the colder core metal that does not go through the transformation. In furnace hardening the whole piece is heated above the critical temperature, and, in rapid cooling, the whole piece goes through the transformation progressively, producing an expansion and contraction in different areas of the piece at different times.[18]

It is of course possible to relieve some of these stresses by a prompt tempering (drawing) at a temperature low enough to avoid losing any, or at the most, very little, of the hardness. This can be performed in a heat-treating furnace or an oil bath at a temperature of 400 to 500 F. The opinion is general that when a quenched steel is reheated to about 400 F., the interrupted transformations have a chance to complete themselves at least partially, as there is a little atomic motion along with the molecular movement at this low temperature, and this relieves the stresses by internal movements similar to plastic flow in the metal.[18] The part should remain in the draw sufficiently long to relieve the stresses set up by quenching. The drawing period need seldom exceed an hour, excepting for large masses. The part or parts may remain in and cool down with the furnace, they may be removed and cooled in still air or both methods may be used.

Tempering Not Always Needed

While generally recommended, the drawing (tempering) operation is not always necessary, since by carefully controlling the quantity and application of the quenching medium or delaying its application, the hardening treatment may be made self-drawing.[21]

Consideration has been given to the possibilities of stress relieving with the oxyacetylene flame. Such treatment might be carried on concurrently with the flame hardening application. The first tip would employ the sharp flames for heating the surface to above the critical. The quench would follow and, finally, softer stress relieving flames would follow to raise the temperature to the desired tempering range, after which the part would air cool to room temperature. An alternative method would be to flame harden completely, as in normal procedure, then to apply the stress relieving flames. No completely conclusive work has been done as yet on industrial mechanical parts, with such procedure that would allow concrete recommendation. Some use is made of this principle in flame hardening rail ends, by the unit-area hardening method, the rail ends being reheated with the oxyacetylene flame to about 750 F. after flame hardening.

Where parts are machined only, followed by flame hardening and then finish-ground, care must be taken not to set up grinding stresses. Such may occur, resulting in surface checks, when too severe a grinding procedure is employed. Slow, fine, and preferably wet grinding should be employed.

The next installment of this series appears in an early number.

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ALTERNATE STEELS For Emergency Use

ALLOY STEELS of all kinds are now subject to priority control under the terms of General Preference Order M-21, issued by the Priorities Division of the Office of Production Management. Supplementary Order M-21-a includes the following definition: "For the purposes of this order 'alloy steel' means any steel, and 'alloy iron' means any iron, containing any one or more of the following elements in the following amounts: manganese in excess of 1.65 percent; silicon in excess of 0.60 percent; copper in excess of 0.60 percent; and aluminum, chromium, cobalt, columbian, molybdenum, nickel, titanium, tungsten, vanadium, zirconium or any other alloying elements in any amount specified or known to have been added to obtain a desired alloying effect."

Nickel and tungsten steels were the first to be placed on the priority list. Now, with the other alloying elements being restricted, the availability of alloy steels with decreasing percentages of restricted elements may well be the controlling factor in their use for less important defense items as well as non-defense items.

Good grades of carbon steel, made to close specifications of analyses, grain size and cleanliness, will meet many requirements. But, in other cases, carbon steel will not harden properly, especially in large sections, because the parts will not cool fast enough when quenched in oil or even in water. Consequently, it is unlikely that alloy steels will be completely banned for non-defense work. Furthermore, considerable amounts of low-alloyed steel will be available through the reclamation of elements from scrap material which at present is not affected by priority control. In addition, steel of all kinds can be furnished by steel producers for non-defense work in amounts up to 10 percent of average sales for the first three months of 1941.

POSSIBLE ALTERNATES

This article discusses the working of possible alternates for steels most restricted by government priorities, that is, those with low percentages of the alloying elements most needed in the production of items essential to the National Defense Program. Specially treated steels, as by the Grainal process, the medium-manganese and straight-molybdenum types are the most hopeful alternates. The chromium, chromium-molybdenum and chromium-vanadium steels have excellent properties, but their availability may be clouded by the possibility of future shortages.

Manufacturers who heretofore have used the high alloy steels, either because of the physical properties obtainable or the ease with which they can be processed, will have to use steels with lesser percentages of the restricted elements. This may apply to defense, as well as non-defense production. In some cases, the alternate materials will not be equivalent in physical properties and working characteristics to those used originally. On the other hand, in some applications, it may be found that an actual improvement in machinability, hardening characteristics and physical properties can be obtained by changing to steels of chemical specifications which avoid the more rigid restrictions of governmental regulation.

The principal difficulty in the use of such alternate steels will be in holding them to closer limits on specifications, and in heat-treating them within narrower ranges. Both of these can be done but only by intensifying metallurgical control over plant operations, which obviously will increase production costs.

These facts are particularly true regarding alternates for high nickel alloy steels and high tungsten high-speed steels. The nickel steels are hardenable to greater depth in heavy sections and permit attainment of a higher order of properties in large heavy-duty parts than possible with shallow hardening steels. Selection of suitable alternates will require not only a study of physical

This special section was made possible through the cooperation of the following organizations:

American Iron & Steel Institute
Allegheny Ludlum Steel Corporation
American Society of Mechanical Engineers
American Society for Metals
Bethlehem Steel Company
Carboloy Company, Incorporated
Cleveland Twist Drill Company
Columbia Tool Steel Company
Crucible Steel Company of America
A. Finkl & Sons Company
Faitoute Iron & Steel Company
General Electric Company
Gisholt Machine Company
C. I. Hayes, Incorporated
Henry Disston & Sons, Incorporated
Hevi Duty Electric Company
E. F. Houghton Company
International Nickel Company
Jessop Steel Company
Latrobe Electric Steel Company
Lindberg Steel Treating Company
Office of Production Management
Park Chemical Company
Republic Steel Corporation
Joseph T. Ryerson & Son, Incorporated
Society of Automotive Engineers
Surface Combustion Corporation
Timken Roller Bearing Company, Steel and Tube Division
Universal Cyclops Steel Corporation
Vanadium Alloys Steel Company
Vanadium Corporation of America

properties attainable with the alternate steels, but also changes in heat-treating technique to produce suitable characteristics. In other instances design changes will have to be made before the alternate steel can be used satisfactorily. On the other hand, molybdenum high-speed steels can be used as satisfactory replacements for the high tungsten types, even though the former have a tendency to develop soft surfaces when heated to hardening temperatures. Because of this tendency, it is necessary and important to exercise certain precautions, discussed later in this article, to protect the surface of these steels.

TYPES OF STEEL

The steels discussed in this article may be divided into three general classes: (1) The oil- or water-hardening steels containing from about 0.25 to 0.55 percent carbon, which are used where deep-hardening characteristics are desired. (2) The carburizing steels, usually containing less than 0.25 percent carbon, which are used where a very hard wearing surface is to be obtained accompanied by good toughness and shock resistance in the core of the finished part. (3) The high-speed and hot-work steels, which in the majority of cases prior to priority regulations were high in tungsten, but now are being replaced by molybdenum or molybdenum-tungsten steels of equivalent properties.

Many of the steels in the first two groups have contained high percentages of nickel, which produces the effects previously mentioned. It should be noted that nickel is not the only element which produces certain desirable characteristics in steels, such as improvement in hardenability or mechanical properties. Chromium, molybdenum, manganese, vanadium and other elements also exert similar effects when added to the steel in proper quantities. Consequently, where mechanical properties alone are the important consideration, it is not too difficult to choose an available substitute for the nickel steels. The tables of properties included in this article should prove helpful in this respect. Steels of approximately equivalent hardening power can be heat-treated to develop approximately equivalent mechanical properties. Hence, the SAE 4100 steels are generally adequate substitutes for the 3100 series, while SAE 6100 steels can be used in place of the SAE 4600 and 2300 series.

Such substitutions may require adjustments in plant practice. Consideration involving heat-treatment technique and machining practice have played just as important a part in the choice of nickel steels as their mechanical properties. These characteristics are not subject to accurate definition, because the variables involved in fabricating technique are exceedingly complex. They differ from one steel to another, and sometimes even between two heats of the same steel. Nickel steels have often been used because they are uniform in their performance from heat to heat. Their insensitivity to variations in heat-treatment technique have made them popular on production lines not subject to close metallurgical control. One of the results of the priority program will be to tighten specifications, and to intensify metallurgical control over plant operations.

One of the most difficult substitution problems lies in the field of heavy-duty, deep-hardening steels. The SAE 2500, 4800, 3300 and 4300 steels are unexcelled for heavy-duty service in large sizes, and there exists no commercial SAE steels without nickel having truly comparable, deep-hardening properties. Compromise can be effected by using a steel of lesser hardening capacity such as SAE 6100 and 4100 series and increasing the severity of the quench. If this procedure proves inadequate, redesign of the part to permit lower unit stresses is the only recourse. Some of the steel companies have on the market certain proprietory steels for heavy-duty parts which may adequately serve as alternates for some priority steels.

Table 1—OIL AND WATER-HARDENING STEELS WITHOUT NICKEL

SAE	Carbon	Manganese	Phosphorous max.	Sulphur max.*	Chromium	Molybdenum	Vanadium
1025	0.20–0.30	0.30–0.60	0.045	0.055	.....	.....	.....
X1025	0.20–0.30	0.70–1.00	0.045	0.055	.....	.....	.....
1030	0.25–0.35	0.60–0.90	0.045	0.055	.....	.....	.....
1035	0.30–0.40	0.60–0.90	0.045	0.055	.....	.....	.....
1040	0.35–0.45	0.60–0.90	0.045	0.055	.....	.....	.....
1045	0.40–0.50	0.60–0.90	0.045	0.055	.....	.....	.....
1050	0.45–0.55	0.60–0.90	0.045	0.055	.....	.....	.....
1055	0.50–0.60	0.60–0.90	0.040	0.055	.....	.....	.....
1060	0.55–0.70	0.60–0.90	0.040	0.055	.....	.....	.....
1065	0.60–0.75	0.60–0.90	0.040	0.055	.....	.....	.....
X1065	0.60–0.75	0.90–1.20	0.040	0.055	.....	.....	.....
1070	0.65–0.80	0.60–0.90	0.040	0.055	.....	.....	.....
1075	0.70–0.85	0.60–0.90	0.040	0.055	.....	.....	.....
1080	0.75–0.90	0.60–0.90	0.040	0.055	.....	.....	.....
1085	0.80–0.95	0.60–0.90	0.040	0.055	.....	.....	.....
1090	0.85–1.00	0.60–0.90	0.040	0.055	.....	.....	.....
1095	0.90–1.05	0.25–0.50	0.040	0.055	.....	.....	.....
X1330	0.25–0.35	1.35–1.65	0.045	0.10–0.20	.....	.....	.....
X1335	0.30–0.40	1.35–1.65	0.045	0.10–0.20	.....	.....	.....
X1340	0.35–0.45	1.35–1.65	0.045	0.10–0.20	.....	.....	.....
1330	0.25–0.35	1.60–1.90	0.040	0.050	.....	.....	.....
1335	0.30–0.40	1.60–1.90	0.040	0.050	.....	.....	.....
1340	0.35–0.45	1.60–1.90	0.040	0.050	.....	.....	.....
1350	0.45–0.55	1.60–1.90	0.040	0.050	.....	.....	.....
4032**	0.30–0.35	0.70–0.90	0.040	0.040	.....	0.20–0.30	.....
4037**	0.35–0.40	0.70–0.90	0.040	0.040	.....	0.20–0.30	.....
4042**	0.40–0.45	0.70–0.90	0.040	0.040	.....	0.20–0.30	.....
4047**	0.45–0.50	0.70–0.90	0.040	0.040	.....	0.20–0.30	.....
4063**	0.60–0.67	0.70–0.90	0.040	0.040	.....	0.20–0.30	.....
4065**	0.62–0.70	0.70–0.90	0.040	0.040	.....	0.20–0.30	.....
X4130	0.25–0.35	0.40–0.60	0.040	0.050	0.80–1.10	0.15–0.25	.....
4140	0.35–0.45	0.60–0.90	0.040	0.050	0.80–1.10	0.15–0.25	.....
4150	0.45–0.55	0.60–0.90	0.040	0.050	0.80–1.10	0.15–0.25	.....
5140	0.35–0.45	0.60–0.90	0.040	0.050	0.80–1.10	.....	.....
5150	0.45–0.55	0.60–0.90	0.040	0.050	0.80–1.10	.....	.....
52100	0.95–1.10	0.20–0.50	0.030	0.035	1.20–1.50	.....	.....
6135	0.30–0.40	0.60–0.90	0.040	0.050	0.80–1.10	.....	0.15–0.18***
6150	0.45–0.55	0.60–0.90	0.040	0.050	0.80–1.10	.....	0.15–0.18***

* Values given are maximum unless a range is specified.

** These grades are American Iron & Steel Institute standard steels.

*** The lower value is the minimum permissible, while the higher is the one desired.

THE SELECTION OF A STEEL

The selection of a steel will depend upon the importance of the production item and its relation to defense work. In some cases, even low-nickel alloy steel may be permissible when the use of the higher nickel steels are prohibited. In other cases, a non-nickel steel will be indicated, even though the alloying elements in it may be under priority control. The working of all grades of SAE nickel alloy steels was published in a previous article (*AM*—Vol. 83, pages 865 to 876). Although some of these steels are mentioned here as possible alternates for the higher nickel steels, data relative to working them are not repeated.

MEDIUM-CARBON STEELS

The medium-carbon steels are oil- and/or water-hardening. Hardness penetration varies over considerable range, depending upon the analysis and heat-treatment used. They may be divided according to the condition in which they are used as follows:

1. The 0.25 to 0.35 percent carbon group, used with a tensile strength range of 100,000 to 150,000 lb. per sq.in., and a Brinell hardness range of 200 to 300. They may be oil or water-hardened, depending upon analyses and properties desired.

2. The 0.40 to 0.55 percent carbon group, all of which are oil-hardened:

(a) Sometimes used in the fully hardened condition but drawn only for strain relief. Brinell hardness ranges from 550 to 600, while the tensile strength ranges from 275,000 to 300,000 lb. per sq.in.

(b) Or hardened and drawn at higher temperatures, giving a Brinell hardness range of 350 to 450, and a tensile strength range of 175,000 to 225,000 lb. per sq.in.

(c) Or hardened and drawn (usually at the mills in bar form) to ranges which may be machined in the heat-treated condition and put into service without further treatment. Brinell hardness ranges from 275 to 325, while tensile strength ranges from 140,000 to 170,000 lb. per sq.in.

The standard SAE specifications of the available grades without nickel are given in Table 1.

As a guide to types of applications on which the alloy steels of these types have been successfully used, the following examples are cited:

SAE 4037 and 4065—AUTOMOTIVE PARTS: bolts, pinion shafts, front and rear axles, leaf and coil springs, cylinder-head studs, steering arms and knuckles. HAND TOOLS: Chisels, hammers, and screw drivers, gears.

SAE 4130, 4145, 4150 — AIRCRAFT ENGINES: propeller blades, bolts, nuts, studs, connecting rods, crankshafts, structural parts and tubing. AUTOMOTIVE PARTS: steering arms, knuckles, connecting rods, crankshafts, splined shafts, rear axles. CONSTRUCTION MACHINERY: eye bars, cantilever pins, chain pins, gears, sprockets and shafts. HYDRAULIC MACHINERY: impellers, rams, shafts, spindles and tool holders. MARINE ENGINES: crankshafts and bolts. STEEL MILLS: connecting rods, shafts and spindles. OIL INDUSTRY: bolts, couplings, side bars, shafting, drill collars, bars, kelly bars, reamer bodies, pull rods, rotary table shafting, pump rods, and tool joints.

SAE 5045 — AUTOMOTIVE PARTS: clutch shafts and transmission main shafts.

SAE 5150 — AUTOMOTIVE PARTS: leaf and coil springs, steering worms, transmission gears and transmission spline shafts. CONSTRUCTION MACHINERY: scarifier teeth, bucket teeth, stone crusher jaws, and hand hammers. MACHINE TOOLS: gears, wear-resisting parts.

SAE 6130, 6140, 6145, 6150—AIRCRAFT ENGINES: propeller hubs and blades, coil springs, piston pins, knuckle pins, connecting rods and crankshafts. AUTOMOTIVE PARTS: differential pinions, side gears, leaf and coil springs. HAND TOOLS: chisels, hammers, pliers, screw drivers and

Table 2—PROPERTIES OF NICKEL AND ALTERNATE STEELS*

Nickel steel and suggested alternates	Preference**	Availability**	Tensile strength, lb. per sq. in.		Reduction of area, percent	Drawn to Brinell hardness of
			Ultimate	Yield		
SAE grades to be replaced:						
2330	....	....	145,000	110,000	57	300
3130	....	....	148,000	120,000	58	300
3135	....	....	152,000	124,000	54	300
Alternates for the above three grades:						
4130	1	C	155,000	138,000	59	300
6135	2	D	145,000	130,000	61	300
X4130	3	E	150,000	128,000	59	300
4037	4	F	152,000	138,000	55	300
X1335	5	A	145,000	126,000	47	300
1040	6	B	135,000	108,000	45	300
SAE grades to be replaced:						
2340	....	....	187,000	176,000	50	400
2345	....	....	193,000	180,000	48	400
3145	....	....	208,000	180,000	42	400
3240	....	....	200,000	177,000	45	400
4340	....	....	207,000	185,000	51	400
Alternates for the above five grades:						
4140	1	A	215,000	185,000	45	400
4150	1	A	220,000	190,000	42	400
6135	2	B	193,000	185,000	51	400
6150	2	B	207,000	185,000	51	400
5150	3	C	200,000	175,000	50	400
SAE grades to be replaced:						
2345	....	....	265,000	230,000	32	534
3145	....	....	260,000	220,000	25	514
3240	....	....	275,000	240,000	37	555
4645	....	....	268,000	230,000	38	534
Alternates for the above four grades:						
4150	1	A	275,000	235,000	29	555
6150	2	B	275,000	235,000	26	555
4065	3	C	265,000	238,000	25	534

* Values given are for specimens 1 in. round oil-quenched from optimum temperature for each grade, and drawn to the hardness indicated.

** Numerals indicate preferable alternates in each of the groups, No. 1 being the one most generally preferred. Letters indicate possible availability of the steels, *A* being most available, while *F* is the least available.

Note: See Table 1 for chemical analyses of the alternate steels.

Table 3—DUCTILITY OF NICKEL AND ALTERNATE STEELS TREATED TO SAME ULTIMATE STRENGTH*

Nickel steels and suggested alternates	Tensile strength, lb. per sq. in.		Reduction of area, percent	Elongation in 2 in., percent	Brinell hardness
	Ultimate	Yield			
SAE grades to be replaced:					
2330	150,000	118,000	57.0	20.0	300
3130	150,000	135,000	56.0	18.0	310
3135	150,000	120,000	57.0	17.0	285
Alternates for the above three grades:					
4130	150,000	135,000	56.5	18.5	305
6135	150,000	133,000	61.0	17.0	305
X4130	150,000	123,000	59.0	21.0	315
4037**	150,000	138,000	60.0	19.0	280
X1335	150,000	120,000	46.0	17.0	290
1040	150,000	98,000	40.0	14.0	300
SAE grades to be replaced:					
2340	150,000	135,000	58.0	20.0	320
2345	150,000	140,000	57.0	18.0	325
3145	150,000	130,000	55.0	17.0	300
3240	150,000	130,000	57.0	18.0	310
4340	150,000	130,000	58.0	20.0	320
Alternates for the above five grades:					
4140	150,000	130,000	56.0	16.0	305
4150	150,000	133,000	50.0	17.0	310
6135	150,000	140,000	54.0	20.0	307
6150	150,000	143,000	52.0	17.0	320
5150	150,000	130,000	54.0	15.0	310
SAE grades to be replaced:					
2345	150,000	140,000	57.0	18.0	325
3145	150,000	132,000	56.0	18.0	300
3240	150,000	130,000	57.0	18.0	310
4645	150,000	132,000	56.0	18.5	305
Alternates for the above four grades:					
4150	150,000	130,000	57.0	17.0	285
6150	150,000	141,000	53.0	18.0	315
4065**	150,000	139,000	54.0	18.5	310

* Values given are for specimens 1 in. round oil-quenched from 1500–1550 F. values taken from tables and charts at 150,000 lb. per sq. in. to compare ductility of the steels.
** American Iron & Steel Institute designations.
Note: See Table 1 for chemical analyses of the alternate steels.

Table 4—CARBON AND LOW ALLOYED CARBURIZING STEELS WITHOUT NICKEL

Steel No.	Carbon	Manganese	Phosphorous max.*	Sulphur max.*	Chromium	Molybdenum	Vanadium
1010	0.05–0.15	0.30–0.60	0.045	0.055	.....	.....	.....
1015	0.10–0.20	0.30–0.60	0.045	0.055	.....	.....	.....
X1015	0.10–0.20	0.70–1.00	0.045	0.055	.....	.....	.....
1020	0.15–0.25	0.30–0.60	0.045	0.055	.....	.....	.....
X1020	0.15–0.25	0.70–1.00	0.045	0.055	.....	.....	.....
1025	0.20–0.30	0.30–0.60	0.045	0.055	.....	.....	.....
X1025	0.20–0.30	0.70–1.00	0.045	0.055	.....	.....	.....
1030	0.25–0.35	0.60–0.90	0.045	0.055	.....	.....	.....
1112	0.08–0.16	0.60–0.90	0.09–0.13	0.10–0.20	.....	.....	.....
1115	0.10–0.20	0.70–1.00	0.045	0.10–0.20	.....	.....	.....
X1314	0.10–0.20	1.00–1.30	0.045	0.10–0.20	.....	.....	.....
X1315	0.10–0.20	1.30–1.60	0.045	0.10–0.20	.....	.....	.....
4023**	0.20–0.25	0.70–0.90	0.040	0.040	.....	0.20–0.30	.....
4024**	0.20–0.25	0.70–0.90	0.040	0.035–0.050	.....	0.20–0.30	.....
4027**	0.25–0.30	0.70–0.90	0.040	0.035–0.050	.....	0.20–0.30	.....
4032**	0.30–0.35	0.70–0.90	0.040	0.040	.....	0.20–0.30	.....
4119**	0.17–0.22	0.70–0.90	0.040	0.040	0.45–0.65	0.20–0.30	.....
4120**	0.17–0.22	0.70–0.90	0.400	0.040	0.60–0.80	0.20–0.30	.....
4130**	0.28–0.33	0.40–0.60	0.040	0.040	0.80–1.10	0.15–0.25	.....
5120	0.15–0.25	0.60–0.90	0.040	0.050	0.60–0.90	.....	.....
5130**	0.28–0.33	0.70–0.90	0.040	0.040	0.80–1.10	.....	.....
6120**	0.17–0.22	0.70–0.90	0.040	0.040	0.70–0.90	.....	0.10 min.

*Values given are maximum unless a range is specified.
**These grades are American Iron & Steel Institute standard steels. Others are SAE steels.

In the event it is necessary to replace a nickel type alloy steel with one of the above types, Tables 2 and 3 will indicate the SAE grade which may be selected and the approximate comparative physical properties which may be obtained. By comparing the respective qualities, a replacement may be made which in some cases will provide certain advantages.

CARBURIZING TYPES

The types of steel used for carburizing purposes are usually of a carbon content of less than 0.25 percent. Within this range, the various compositions have been developed for respective characteristics of toughness, strength, hardness and physical properties of the core. The types may in general be classified:

1. Those which are directly quenched from the carburizing temperature.
2. Those which are pot-cooled from the carburizing temperature, reheated and quenched in oil.
3. Those which are quenched directly from the carburizing pot, followed by tempering.
4. Those which are pot-cooled, followed by two successive reheating and quenching operations.

For these applications, the higher nickel alloyed types have long had a preference because of their ability to resist grain growth during the long high-temperature heating for carburizing; their response to single-quenching treatment, giving a hard core to support the case when it is subjected to hard service. When it is necessary to replace these types, such as SAE 2515, 3312, 4815 and 4320, it is difficult to recommend material which will equal these physical characteristics. However, the lower nickel types such as 2320, 3120 and 4620 may in general be replaced by such types as SAE 4120, 6120, 4022 and in some cases, X1315 and 1015 with reasonable satisfaction.

The standard SAE chemical specifications of the available grades without nickel are given in Table 4.

These steels have been successfully applied on the following types of parts:

SAE 4120 — AUTOMOTIVE PARTS: gears, knuckle pins, shafts and collars. OIL INDUSTRY: drilling cutters. MACHINE TOOLS: antifriction bearings, pins and shafts.

SAE 6120 — AUTOMOTIVE PARTS: piston pins, differential and

transmission gears. OIL INDUSTRY: bit and reamer cutters. MACHINE TOOLS: gears, arbors and collets.

SAE 4022 and 5120 have not yet seen wide service but have properties indicating similar possible applications to the above grades.

SAE X1315 and 1015 are common grades, readily available from existing sources, but having much lower physical properties and are therefore only to be recommended when other grades are not readily obtainable for the purpose required.

Table 5 outlines the relative physical values of the grades generally available.

In the field of low carbon steels are many applications where the material is used with low hardness values, without carburizing, in the as-rolled, normalized or quenched and drawn condition. Table 6 outlines these typical uses and the steels which may be used.

HEAT-TREATMENT

Recommended heat-treatment of foregoing SAE alloy steels are given in Tables 7 and 8. These are based on tests and experience of steel manufacturers and users, and are intended only as a guide in selecting the proper steels and their heat-treatment. Variations in the effect of the usual forms of heat-treatment may be due to personnel, types of steel compositions or manufacture, and to changes in local conditions such as control and sensitiveness of heat-treating equipment. In order to control such variations, steels users should keep each heat of steel separate in the stockroom and during routing. Preliminary tests should precede all production operations in order that exact details of heat-treatment, particularly the normalizing, quenching and tempering temperatures, may be determined ahead for each piece of steel.

When selecting the steel, the user should keep in mind the importance of obtaining the desired strength and hardness without the necessity of resorting to drastic forms of heat-treatment. Water and brine quenching may be considered as drastic forms when applied to carbon and simple alloy steels containing more than 0.35 percent carbon, and if improperly applied may lead to serious cracking and distortion. Frequently, drastic treatments can be avoided by control of grain size and by selecting a steel with either a slightly higher carbon content or with a little greater alloy content. Such discretion is important in the case of parts of intricate shapes and sudden changes in section.

To obtain uniform physical properties make the final quench from the lowest temperature that will develop the maximum physical properties; with thinner sections, lower temperatures are used than with thick ones.

When using the lower carbon steels, simple normalizing is often sufficient to place the steel in its best condition for machining and will lessen distortion in carburizing or hardening. In the more richly alloyed steels, combined normalizing and annealing constitutes best practice. For unimportant parts, the normalizing may be omitted entirely or annealing practiced only when the steel is otherwise difficult to machine.

SPECIAL ALLOYS

The steel companies have special steels which have low percentages of the restricted elements. These together with others that will soon be developed will find extended use. A further advance seems now to have been recorded by the development of a means of securing high hardenability not only in coarse-grained but also in fine-grained steels without the heretofore required large amounts of alloying elements. A group of alloys has been produced that secure this result with only very small additions (of the order of hun-

Table 5—CORE PROPERTIES OF TYPICAL CARBURIZING STEELS*

Nickle steels and suggested alternates SAE grades to be replaced:	Preference*	Availability**	Tensile strength, lb. per sq. in. Ultimate	Tensile strength, lb. per sq. in. Yield	Elongation in 2 in., percent	Reduction of area, percent	Brinell hardness	Carbon content, percent
2320.....	.....	.....	150,000	122,000	17.0	42	330	0.17
3120.....	.....	.....	132,000	100,000	17.5	44	270	0.22
4620.....	.....	.....	130,000	100,000	17.5	54	280	0.20
Alternates for the above three grades:								
6120.....	1	C	127,000	105,000	19.0	53	268	0.19
4120***.....	1	D	137,000	110,000	18.0	51	293	0.20
4023***.....	2	F	130,000	95,000	18.0	50	285	0.24
5120.....	3	E	128,000	104,000	16.5	48	277	0.18
X1315.....	4	B	102,000	73,000	23.0	58	207	0.14
1015.....	5	A	82,000	55,000	28.0	68	160	0.13

* Values given are for specimens 1 in. round, carburized 8 hr. at 1,680 F., oil quenched, and drawn 1 hr. at 400 F.

** Numbers indicate order of preference with used in place of the nickel grades, No. 1 being the most preferred. The letters indicate availability of the steel, *A* being the most available.

*** American Iron & Steel Institute designations; others are SAE Steels. See Table 4 for Chemical analysis.

Table 6—SPECIALIZED STEELS AND SUGGESTED ALTERNATES*

Currently used steel designation or description	Uses	Possible alternate, standard steel designation or description
2.75% Ni—0.25% C	Railroad axles, main and side rods, piston rods and crankpins	1.45–1.75% Mn—0.15% V
2.25% Ni—Low C	Boiler tubes and boiler plates	0.40–0.60% Mo—Low C; Mn-V, ASTM spec. A225
A.I.S.I. No. 2115	Engine bolts	0.15–0.25% Mo—0.75 Ni
A.I.S.I. No. 3115	Engine bolts	A.I.S.I. Nos. 4000, 4100, 5100 and 6100
A.I.S.I. No. 4620	Sucker rods	A.I.S.I. No. 6100; 0.40–0.60% Mo—Low C
3.50% Ni—MoC	Sucker rods	0.40–0.60% Mo—Low C; A.I.S.I. No. 6100
A.I.S.I. No. 4820	Sucker rods	0.40–0.60% Mo—Low C; A.I.S.I. No. 6100
A.I.S.I. No. 2515	.....	A.I.S.I. No. 6100
A.I.S.I. No. 2315	.....	A.I.S.I. No. 6100

* From "Possible Substitutes for Nickel Steels"; courtesy American Iron & Steel Institute.

Note: In order to substitute successfully as indicated, it will be necessary to study the problem thoroughly and do some experimental work.

dredths of one percent) in the final stages of steelmaking, yielding products of exceptional uniformity and furthermore providing high toughness at high hardness without large alloying additions. These alloys are commercially designated by the name of "Grainal".

The results obtained with one of these alloys are given in Table 9. They increase penetration of maximum hardness without changing surface hardness appreciably; the effect upon penetration is observed from the hardenability tests by the Jominy method given in Table 9. This makes it possible to use small sections of any particular carbon or low-alloyed steel that would have to be used in larger sections to obtain strength requirements if the process were not used. Also, a steel lower in alloying elements can be used for jobs where previously a more highly alloyed steel has been required. Consequently, the process becomes a definite means of conserving alloying elements needed in defense items.

The particular alloy used to develop these properties in the steels described contains approximately 25 percent vanadium, 15 percent titanium and 10 percent aluminum and is usually added in such amounts that less than 0.10 percent vanadium and often as little as 0.02 percent vanadium is introduced into the melt; the most frequently used addition has been in the range of 2 to 5 lb. of alloy per ton of steel. The change in the response to heat treatment of carbon and low-alloy steels due to this small addition is evident from Table 9.

Typical applications of the carburizing and deep hardening steels herein discussed are given in Table 10.

MOLYBDENUM HIGH-SPEED STEELS*

The present necessity of conserving tungsten has resulted in a large scale substitution of molybdenum for tungsten high-speed tool steels. In the majority of applications replacement of tungsten with one of the molybdenum types has been successfully made.

In considering the various types of molybdenum high-speed steel, two general classifications must be made.

The first is based upon the component alloying elements, tungsten, molybdenum, vanadium and cobalt. The varieties of the combinations of these elements is outlined in Table 11. These are there arranged opposite the corresponding tungsten grades as an indication of their relative properties and applications.

The second general classification is based upon the carbon range of any given alloyed steel. The carbon range shown in Table 11, actually covers the ranges of three possible types. On the low side of the carbon range, the steel is useful for dies, planer tools, form cutters, lathe tools and any type of application where toughness is of primary importance and can be preferred to high red hardness and long wear. When the carbon is within the middle range, the steel is especially useful for drills, milling cutters, broaches, extrusion dies, file cutting chisels, gear cutters, shear blades, taps and dies and for general applications where the combined toughness and red hardness are desired. When the carbon is in the high range, the steel is especially useful for reamers, lathe tools, burnishing tools, cut-off tools, roll turning tools, thread chasers, tire turning tools and all applications where the maximum hard-

* Data in this section were obtained in part from committee reports prepared under the auspices of the Office of Production Management, and under the direction of Mr. Bradley Stoughton, Chief, Heat-Treating Equipment Unit, Tools Section, OPM.

TABLE 7—HEAT-TREATMENT FOR SAE CARBURIZING STEELS WITHOUT NICKEL

SAE No.	Treatment	Normalize	Carburizing temp., F.	Cooling method	Reheat, F.	Cooling medium	Second Reheat, F.	Cooling medium	Tempering temp., F.
1010	I	.....	1650–1700	W or B	.....	.....	.....	.....	250–325
1015	II	.....	1650–1700	O or W	1400–1450	W or B	.....	.....	250–325
X1015	III	.....	1650–1700	Slow	1400–1450	W or B	.....	.....	250–325
1020	IV	.....	1650–1700	Slow	1650–1700	O or W	1400–1450	W or B	250–325(1)
1025									
X1025	III	.....	1500–1650(2)	O or W	.....	.....	.....	.....	See note(1)
1030									
1112	I	.....	1500–1650(2)	O or W	.....	.....	.....	.....	See note(1)
	I	.....	1650–1700	O or W	.....	.....	.....	.....	250–325
1115	II	.....	1650–1700	O or W	1400–1450	O or W	.....	.....	250–325
X1314	III	.....	1650–1700	Slow	1400–1450	O or W	.....	.....	250–325
X1315	IV	.....	1650–1700	Slow	1650–1700	O or W	1400–1450	W or B	250–325
	V	.....	1500–1650(2)	O or W	.....	.....	.....	.....	See note(1)
	I	Yes(3)	1650–1700	OQ	1425–1475(4)	O	.....	.....	250–300
		Yes(3)	1650–1700	OQ	1475–1525(5)	O	.....	.....	250–300
	II	Yes(3)	1650–1700	Slow	1425–1475(4)	O	.....	.....	250–300
5120		Yes(3)	1650–1700	Slow	1475–1525(5)	O	.....	.....	250–300
	III	Yes(3)	1650–1700	Slow	1600–1650	O	1425–1475	O	250–300
	IV	.....	1500–1650(6)	OQ	.....	.....	.....	.....	See note(1)

These instructions, recommended by the Society of Automotive Engineers, are only for guidance in selecting proper materials for different purposes, and should not be incorporated in specifications when ordering steel.

(1) Tempering is optional with this treatment.

(2) This treatment is for activated or cyanide baths and parts may be given refining heats as indicated for other heat-treating processes.

(3) After normalizing this may be followed by a low-temperature anneal or slow cooling.

(4) This treatment when case hardness only is paramount.

(5) This treatment when higher core hardness is desired. Normalizing temperatures should be at least 50 F. above carburizing temperatures. Where cycle normalizing and annealing is recommended, it is usually combined in one operation to produce the desired condition for machinability. When fine grained steels are employed, a second reheat is often necessary.

(6) For fine grained steels and for gas carburized steels when automatic quenching is practiced.

W = water; O = oil; B = brine; OQ = oil quench.

ness, combined with long wear is desired, with some sacrifice of toughness.

In all cases, it must be observed that the carbon range in a steel of the molybdenum type is about 0.08 to 0.10 percent higher than the corresponding type of 18 percent tungsten type. This higher percentage of carbon is required, since it goes into solution in that larger proportion when the steel is hardened.

In comparing molybdenum high-speed steels with tungsten types, it must be taken into consideration that the molybdenum type is approximately 8 percent lower in weight than the tungsten types. It is also lower in price at the present time on the per pound basis, but has a correspondingly lower scrap value. In the annealed state, the hardness is about 10 to 20 points lower on the Brinell scale than corresponding grades of tungsten steel. In general forging and heat treatment is slightly more exacting because of the necessity of protecting the surface from decarburization and protecting from grain growth at the high heat. However, the finished tools are considered as at least equal to the corresponding tungsten types.

In selecting a molybdenum high speed steel, the first step is to determine the grade which most nearly duplicates the type of tungsten high speed steel which has been known to best perform on the specific work involved.

Table 11 lists on the left the various analyses of tungsten steels. Directly opposite, on the right of each grade are corresponding molybdenum grades.

Table 8—HEAT-TREATMENT FOR SAE OIL AND WATER-HARDENING STEELS WITHOUT NICKEL

SAE No.	Treatment	Normalize	Anneal	Hardening temp., F.	Quench medium
1025, X1025, 1030	I	.....	.....	1575–1650	W
	II	1700–1800	.....	1575–1650	W
1035, 1040	I	.....	.....	1525–1575	O or W
	II	1650–1750.....	.....	1525–1575	O or W
1045, 1050	I	.....	.....	1450–1550	O or W
	II	1600–1700	.....	1475–1525	O or W
1055	....	1550–1650 and/or	1400–1500	1450–1550	O or W
1060, 1065, X1065, 1070	I	1550–1650 and/or	1400–1500	1450–1550	O
1075, 1080, 1085	I	1550–1650 and/or	1400–1500	1450–1500	O
1090, 1095	I	.....	1400–1500(1)	1430–1500	O, W, B
	II	.....	1400–1500(1)	1500–1600	O
X1330	I	.....	.....	1525–1575	O or W
	II	1600–1700	.....	1525–1575	O or W
X1335, X1340	I	.....	.....	1500–1550	O or W
	II	1600–1700	.....	1500–1550	O or W
1330	I	.....	.....	1525–1575	W or O
	II	1600–1700 and/or	1500–1600	1525–1575	W or O
1335, 1340	I	.....	.....	1500–1550	O
	II	1600–1700 and/or	1500–1600	1525–1575	O
1350	I	.....	.....	1450–1550	O
	II	1600–1700 and/or	1400–1500	1450–1500	O
X4130	I	1600–1700 and/or	1450–1550	1550–1650	W or O
4140	I	1600–1700 and/or	1450–1550	1525–1625	O
4150	I	1600–1700 and/or	1450–1550	1500–1600	O
5140	I	1600–1700 and/or	1450–1550	1500–1600	O
	II	1600–1700 and/or	1450–1550	1475–1525(2)	O
5150	I	1600–1700 and/or	1450–1550	1450–1550	O
	II	1600–1700 and/or	1450–1550	1475–1525	O
52100	I	.....	1350–1450(1)	1425–1475	W
				1500–1600	O
6135	I	1650–1750 and/or	1550–1650	1550–1650	O
6150	I	1650–1750 and/or	1550–1650	1550–1650	O

(1) Cool slowly 7 to 35 hr. for uniformly distributed spheroidized structure.
(2) Gears are often hardened from cyanide baths.
Note: Draw all these steels to the desired hardness.

Table 9—PHYSICAL PROPERTIES AND HARDENABILITY OF PLAIN AND GRAINAL-TREATED STEEL

Steel grade	C	Mn	Si	Cr	V	Heat-treatment	Yield point, lb. per sq. in.	Tensile Strength, lb. per sq. in.	Elong. % in 2 in.	Red. of Area, %	Izod ft.-lb.	Hardenability**
1040*	0.40	0.66	0.14	....	.....	1525 F. WQ+600 F. air	97,500	129,800	18.0	53.3	48.7	0.10
1040*	0.40	0.66	0.14	....	.....	1525 F. WQ+950 F. air	89,650	116,150	22.5	61.3	90.2	....
1040	0.42	0.62	0.22	....	0.03	1525 F. WQ+600 F. air	147,475	182,400	15.2	56.0	23.2	0.17
1040	0.42	0.62	0.22	....	0.03	1525 F. WQ+950 F. air	105,325	127,725	20.2	64.8	83.7	....
1040*	0.38	0.91	0.24	....	.....	1550 F. OQ+550 F. air	93,100	124,700	21.5	64.8	....	....
1040	0.38	0.91	0.24	....	0.029	1550 F. OQ+550 F. air	212,200	257,300	13.5	46.9	....	....
1040*	0.38	0.91	0.24	....	.....	1550 F. WQ+550 F. air	165,500	215,420	13.0	41.3	....	....
1040	0.38	0.91	0.24	....	0.029	1550 F. WQ+550 F. air	210,130	239,950	14.0	56.7	....	....
1055*	0.56	0.92	0.17	....	.....	1525 F. OQ+450 F. air	110,200	158,700	12.5	38.5	4.5	0.17
1055	0.56	0.93	0.16	....	0.028	1525 F. OQ+450 F. air	258,200	301,500	10.0	38.5	5.7	0.23
1055	0.56	0.92	0.17	....	0.050	1525 F. OQ+450 F. air	261,250	302,700	9.0	36.0	6.7	0.33
1055*	0.56	0.92	0.17	....	.....	1500 F. WQ+450 F. air	267,750	295,700	2.0	3.9	....	....
1055	0.56	0.92	0.17	....	0.050	1500 F. WQ+450 F. air	272,650	303,000	6.0	22.3	....	....
1055	0.56	0.92	0.17	....	0.050	1500 F. WQ+450 F. air	276,350	306,200	8.5	34.7	....	....
1340*	0.41	1.83	0.23	....	.....	1500 F. OQ+450 F. air	196,000	252,250	11.0	37.5	6.2	0.33
1340	0.42	1.78	0.24	....	0.048	1500 F. OQ+450 F. air	231,750	269,500	12.5	49.8	18.5	1.50
Mn-Cr*	0.41	0.93	0.27	0.58	.....	1550 F. OQ+450 F. air	220,150	255,700	6.0	23.7	6.0	0.24
Mn-Cr	0.41	0.92	0.28	0.58	0.028	1550 F. OQ+450 F. air	233,500	270,500	10.0	39.1	12.7	0.41
Mn-Cr	0.42	0.92	0.28	0.58	0.063	1550 F. OQ+450 F. air	235,750	275,200	12.5	49.2	15.2	0.62
Mn-Cr*	0.42	0.92	0.28	0.58	.....	1575 F. OQ+900 F. air	106,700	132,000	18.5	60.7	72.5	....
Mn-Cr	0.42	0.92	0.28	0.59	0.063	1575 F. OQ+900 F. air	134,950	153,250	16.0	59.3	61.0	....
Mn-Cr	0.42	0.92	0.28	0.59	0.063	1575 F. OQ+900 F. air	164,350	171,850	14.0	54.7	52.0	....

*Plain steel, not grainal treated.
**Hardenability by the Jominy method: depth in inches from quenched end to a reading of Rockwell 50C.

Table 10—CHARACTERISTICS AND APPLICATIONS OF ALTERNATE STEELS

Steel	Characteristics	Applications
CARBURIZING STEELS		
1015	Good wear resistance, sufficient strength to withstand low service loads	Spline shafts, pushrod sockets, shackle bolts, tie-rod ball studs and sockets, water-pump shafts
X1315	High wear resistance, good carburizing qualities, easily machined	Spline shafts, Pitman and steering arm studs, brake and clutch pedal shafts, valve rocker arms
4023**	Tough core, good wear resistance	Automotive gears and pinions, collets, track pins
4120	Hard tough core, machines easily	Transmission gears, drive pinions, camshafts, oil-well bits, rock drill parts, reamer cutters
5120	Hard case, tough, shock resisting	Roller bearings, machine tool gears and spindles, arbors
6120	Hard, tough, strong case of high wear resistance, little flaking, powdering or flowing under pressure	Roller bearings, gears, camshafts, piston pins, bolts, washers, hydraulic valves and fittings
OIL- AND WATER-HARDENING STEELS		
1040	Fair wear, hardens from low temperatures	Automotive crankshafts, connecting rods, steering arms, front axles, wheel lugs, small flat springs, transmission gears
X1335	Fair wear, good toughness, easily machined	Transmission main shafts, ring gears and pinions
4037**	Good strength, resists fatigue	Connecting rods, drive shafts, gears, axles, bolts, leaf and coil springs, cylinder-head studs, steering arms and knuckles
4065**	High hardness, good wear, deep hardening	Chain pins, boring bars, chisels, collets, pneumatic tool chucks, punches, gears, shafts, studs, springs
4130	Flows well in forging, easily machined, resists creep at high temperatures	Spline shafts, drive shafts, rear axle shafts, connecting rods, aircraft tubing, intake valve stems, drill collars, sucker rods
4140	Hardens uniformly to good depth, good fatigue and shock resistance	Tool holders, piston pins, gears, spline shafts, aircraft propeller blades, studs, bolts, nuts, machinery pins, sprockets, spindles
4150	High in shock resistance, fatigue resistant, good creep resistance, excellent wear, responds well to heat-treatment	Gears, roller bearings, parts subject to high wear and stress, punches, mandrels, collets, bolts, couplings, shafts, pump rods, tools
5150	Wear and fatigue resistant at moderately high strengths	Springs, gears, wear resistant machinery parts, dies, hand tools, wrenches, scarifier teeth, bucket teeth, stone crusher jaws, hand tools
6135	High fatigue resistance, machines easily	Engine intake valve, crankshafts, well-drilling tools, machine tool gears, aircraft propeller hubs and blades
6150	High elastic strength combined with toughness and fatigue resistance	Small bevel and spur gears, rocker arms, small tools, wrenches, diesel engine crankshafts and connecting rods, chisels, screw drivers, pliers, aircraft valve springs, spline shafts, transmission gears, all types of flat and coiled springs, shafting, clutches, collets

NOTE: For applications of low-allowed nickel steels see "Working of SAE Nickel Alloy Steels," *AM*—Vol 83, pages 865–876.
**American Iron & Steel Institute designations; all others are SAE steels.

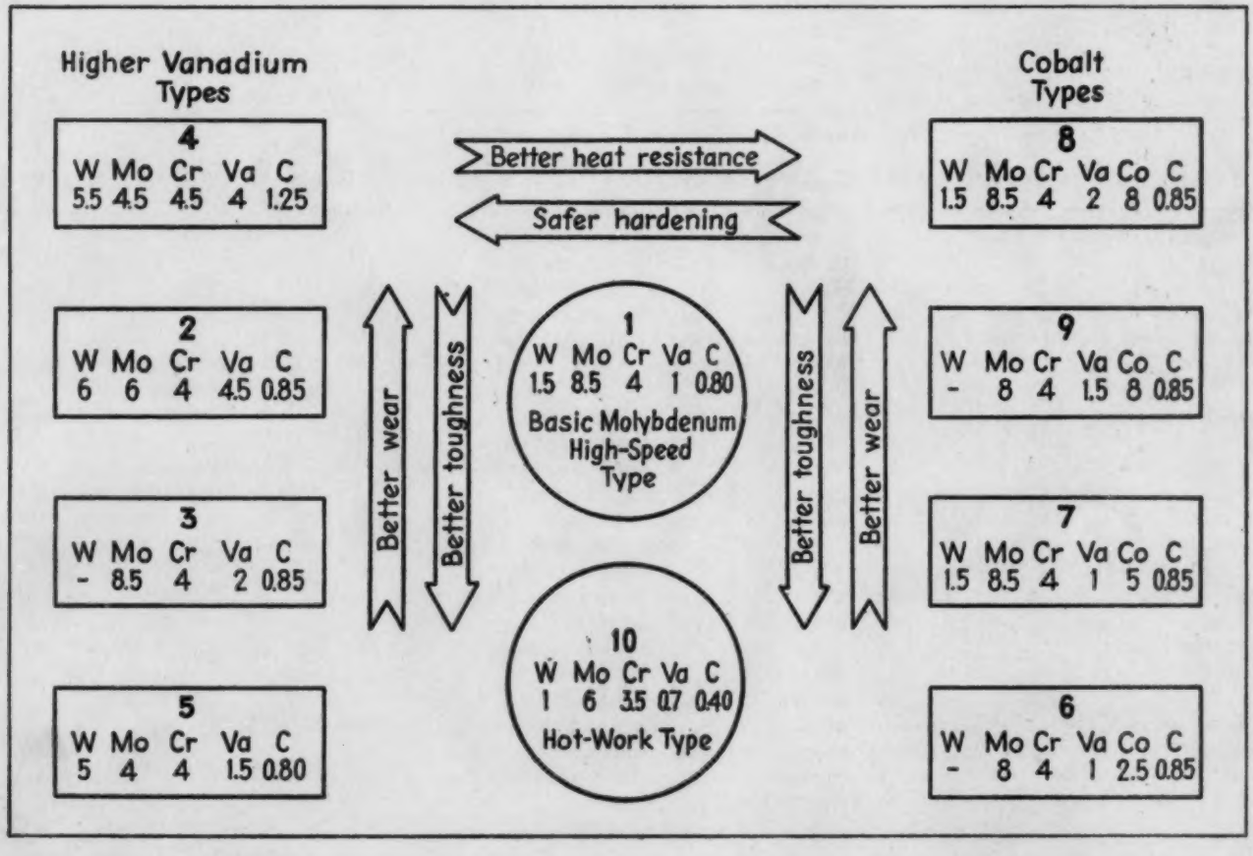


Table 11—TUNGSTEN AND MOLYBDENUM HIGH-SPEED STEELS

High-tungsten types					Corresponding molybdenum types						
Tungsten	Chromium	Vanadium	Cobalt	Carbon	Notes	Tungsten	Molybdenum	Chromium	Vanadium	Cobalt	Carbon
18	4	1	..	0.55–0.80	1	1.25–2.00	8.0–9.5	3.0–5.0	0.90–1.50	...	0.70–0.85
					2	5.00–6.00	3.5–5.5	3.5–5.5	1.25–1.75	...	0.75–0.90
18	4	2	..	0.75–1.05	3	.....	7.5–9.5	3.0–5.0	1.50–2.25	...	0.70–0.90
18	4	3.5	..	0.90–1.30	4	5.00–6.00	4.0–5.0	4.5	4.00	...	0.70–1.30
14	4	2	..	0.55–0.80	5	5.00	4.0	4.0	1.5	...	0.65–0.85
18	4	1	5	0.65–0.80	6	.....	8.0	4.0	1.0	2.5	0.75–0.90
					7	1.60–2.30	8.0–9.0	3.7–4.2	1.00–1.35	5.0	0.76–0.82
18	4	2	8	0.65–0.90	8	1.50	8.5	4.0	2.00	8.0	0.75–0.90
18	4	2	8	0.65–0.90	9	.....	8.0	4.0	1.50	8.0	0.75–0.90
22	5	1.5	12	0.70–0.90	..	.....	.....	.....	.....	...	.....
Hot-work types:											
14	3.5	0.50	..	0.25–0.60	10	1.00	6.00	3.5	0.70	...	0.25–0.50
10	2.5	0.25	..	0.25–0.50							

Notes: Relative effect of decarburization (decreasing): 9, 8, 6, 7, 3, 1, 4, 5, 2, 10
Relative toughness (increasing): 8, 9, 7, 6, 4, 3, 2, 1, 5, 10
Relative wear resistance (increasing): 10, 1, 5, 2, 3, 4, 6, 7, 9, 8

For further comparison of the molybdenum grade the chart indicates relative wearing, toughness, heat resistance and safe hardening characteristics. Type 1 is one of the more common types. Based on this, the higher vanadium types to the left are generally lower in decarburization during hardening. Of this higher vanadium group, Type 4, at the top is best in wear, while Type 5, at the bottom is best in toughness. The cobalt types to the right are all better in heat resistance. In the cobalt group, Type 8 at the top is best in wear and Type 6, at the bottom, is best in toughness.

The three compositions of molybdenum types most widely used are listed in Table 12. These three types of molybdenum steel, Types I and III in particular, may in general be substituted for the 18–4–1 tungsten type. Types II and III are more often used for the 18–4–2 type with satisfactory results. There are additional compositions more highly alloyed which are used for special applications.

Type I which is the Momax type, and Type II the molybdenum-vanadium type, are general purpose high-speed steels which will give performance comparable to the 18–4–1 and in some instances to the 18–4–2 types. Both are subject to decarburization during heating for forging or hardening. To avoid this they must be protected with some coating such as borax or heat treated in a salt bath or controlled atmosphere furnace.

Type III is also a general purpose high-speed steel and was developed as a result of extensive research work to obtain a steel which would resist decarburization. With this proportion of tungsten to molybdenum, tendency to decarburize is greatly reduced and in this respect it closely approximates 18–4–1. Furthermore, the steel compares favorably with 18–4–1 as to forgeability and machinability. It can be handled in heat-treating with the same equipment as 18–4–1 and the hardening range is about 100 F. lower. Tempering is similar to 18–4–1. It has given good results on a variety of applications such as single point cutting tools, drills, reamers, taps, broaches, form tools, and certain kinds of dies. This steel, while newer than Types I and II, has been in commercal production for over three years.

For those who are not skilled in handling molybdenum high speed steels and who do not have decarburization under good control, it is recommended that at present they adopt the following procedure:

1. Use the required substitution of molybdenum high-speed steels, selecting the type that will produce the best results and give the least trouble in working. The smaller tools are heat-treated by shorter cycles and thus the general hazards are less.

2. Proceed on the basis that steels of Type III decarburize less than steels of Type I or II. In most cases steels of Type III can be treated without surface protection in the same equipment used for tungsten high-speed steels.

3. Consult with the firms from whom you purchase your high-speed steels for their best advice in the light of your particular problem.

4. Take steps to obtain modern, efficient hardening equipment on the premise that regardless of the kind of high-speed steel being hardened, proper hardening promotes better tool life and better tool life in itself is a big step in conservation.

Selection of a molydenum type will also depend to some extent on the heat-treating equipment available. Where decarburization is under good control, substitution for the tungsten type does not present much of a problem and anyone of the molybdenum types may be used. Where it is necessary to use existing equipment without atmosphere control and where coatings are undesirable or inconvenient, Type III steel should be used. In most cases Type III can be treated without surface protection in the same equipment used for tungsten steels. If it is desired to use Types I or II under these conditions borax or other coating should be applied.

Table 13 gives recommended temperature ranges to be used with the molybdenum high-speed steels.

FORGING

The molybdenum high-speed steels can be forged like the tungsten type but at a slightly lower temperature. They should not be soaked unduly long at the forging temperature. Large pieces over 4-in. round should be preheated at 1,000–1,200 F. before heating to the forging temperature. No protection is necessary, for ordinary size forgings. Where long heating periods are necessary, coatings should be applied to Types I and II. After forging, cool slowly to about 300 F. to avoid cracks from forging strains. This may be done by cooling in a furnace or buying in lime, mica, dry ashes or other insulating material.

ANNEALING

These steels like other high-speed steels should be annealed after forging and before hardening or when rehard-

Table 12—TYPES OF MOLYBDENUM HIGH-SPEED STEELS

	TYPE I Molybdenum-tungsten a	b*	TYPE II Molybdenum-vanadium	TYPE III Tungsten-Molybdenum
Carbon	0.70–0.85	0.76–0.82	0.70–0.90	0.75–0.90
Tungsten	1.25–2.00	1.60–2.30	.....	5.00–6.00
Chromium	3.00–5.00	3.70–4.20	3.00–5.00	3.50–5.00
Vanadium	0.90–1.50	1.05–1.35	1.50–2.25	1.25–1.75
Molybdenum	8.00–9.50	8.00–9.00	7.50–9.50	3.50–5.50
Cobalt	See note	4.50–5.50	See note	See note

*Cobalt may be used in any of these steels in varying amounts up to 9 percent and the vanadium may be as high as 2.25 percent. When cobalt is used in Type III, this steel becomes susceptible to decarburization. As an illustration of the use of cobalt, Type 1b is included. This steel is T10 in the U. S. Navy Specification 46S37, dated November 1, 1939.

Table 13—HEAT-TREATMENT OF MOLYBDENUM HIGH-SPEED STEELS†

	TYPES Ia and Ib Molybdenum-tungsten	TYPE II Molybdenum-vanadium	TYPE III Tungesten-molybdenum
Forging	1850–2000 F.	1850–2000 F.	1900–2050 F.
Not below	1600 F.	1600 F.	1600 F.
Annealing	1450–1550 F.	1450–1550 F.	1450–1550 F.
Strain relief	1150–1350 F.	1150–1350 F.	1150–1350 F.
Preheating	1250–1500 F.	1250–1500 F.	1250–1550 F.
Hardening*	2150–2250 F.**	2150–2250 F.	2175–2275 F.
Salt	2150–2225 F.	2150–2225 F.	2150–2250 F.
Tempering	950–1100 F.	950–1100 F.	950–1100 F.

†Hardening curves for the various types are included in this article.
*The higher side of the hardening range should be used for the large sections, and the lower side for the small sections.
**Under similar conditions Type 1b requires a slightly higher hardening heat than Type Ia.

ening is required. Box annealing is preferable packing with such materials as lime, fine dry ashes, sand or ground mica mixed with a small amount of burned charcoal or carburizing compound. Heat slowly to the temperature shown in Table 13, hold until thoroughly heated through, and cool slowly in the furnace. The charge should not be removed until cooled below 1,000 F.

After machining and before hardening it may be necessary to use a strain relieving anneal at 1,150 to 1,350 F. Tools should be cooled slowly.

HARDENING

In general, the method of hardening the molybdenum high-speed steels resembles the practice with 18–4–1 but the temperatures (see Table 13) are lower and with Types I and II precautions must be taken to avoid decarburization. This is important when the surface is not ground after hardening. Salt baths and atmosphere controlled furnaces are very good equipment for hardening molybdenum high-speed steel.

The usual method is to preheat uniformly in a separate furnace to 1,250 to 1,550 F. and transfer to a high heat furnace maintained at the hardening temperature (see Table 13). When heated in open fire without atmosphere control, these steels do not "sweat" like 18–4–1 as they approach the hardening heat. Consequently the proper time in the high-heat chamber is a matter of experience. This time is about the same as used with 18–4–1 although slightly longer when the lower part of the hardening range is used. The hardening of preliminary test pieces for check-up on hardness, fracture, and structure is suggested as a help at arriving at the proper time in the high-heat chamber. Factors affecting this time are temperature, type of furnace, size and shape of tools, and furnace atmosphere so definite figures cannot very well be given.

QUENCHING

Tools may be quenched in oil, air or molten bath. Large tools or those with intricate shape are preferably cooled in a molten bath at about 1,100 F. and when equalized, cool in air. When quenched in oil they should be removed when slightly red and cooled in air well down toward room temperature, and tempered promptly to avoid cracking.

TEMPERING

Reheat slowly and uniformly to 950–1,100 F. For general work, 1,050 F. is largely used. Time at temperature should be at least one hour and two to four hours good practice. When tempering is done in molten baths, avoid too rapid heating if tools are intricate in shape and of large size. Where special toughness is desired multiple tempering—usually a double draw is recommended.

Straightening should be done after quenching and before cooling to room temperature prior to tempering.

COATINGS

Borax may be applied by slightly sprinkling over the steel when heated to a low temperature (1,200–1,400 F.). Small tools heated as above may be rolled in a box of borax. Another method more suitable for finished tools is to apply the borax or boric acid in the form of a supersaturated water solution. In such cases the tools are immersed in the solution at 18–212 F., or it may be applied with a brush or spray. Pieces so treated are heated as usual with care taken in the handling to insure good adherence.

Special protective coatings or paints when properly applied have been found extremely useful. They do not fuse or run at the temperatures used and therefore do not affect the furnace hearth. When applying these coatings, it is necessary to have a surface free from scale or grease to insure good adherence. They may be sprayed or brushed on and usually one thin coat is sufficient. Heavy coats tend to pit the surface of the tool and in addition cause difficulty in its subsequent removal. Tools covered with these coatings should be allowed to dry before charging into the pre-heat furnace. After hardening and tempering the coating can be easily removed by light blasting with sand or steel shot. When tools are lightly ground, these coatings come off immediately.

SPECIAL NOTES

As in the case of tungsten high-speed steels, tools with sharp corners, variable cross-sections or very large sizes should not be given too drastic a quench in oil. It is better to remove the tool from the oil when cooled to or just below a red heat and allow it to cool in the air. Equalizing in lead or molten salt at about 1,100 F. and then cooling in still air is good practice.

Single point cutting tools, in general, should be hardened at the upper end of the temperature range as given in Table

13. Slight grain coarsening on such tools is not objectionable when they are properly supported in service and not subjected to chattering.

However, when such tools are used for intermittent cut, it is better to use the middle of the temperature range. All other cutting tools such as drills, countersinks, taps, milling cutters, reamers, broaches, form tools, etc., should be hardened in the middle of the range.

Certain applications requiring a maximum toughness (to resist shocks) will require the lower end of the hardening range. Examples are: slender taps, cold punches, blanking and trimming dies.

The molybdenum high-speed steels may be pack-hardened following the same practice as used with tungsten high-speed steels but keeping on the lower side of the hardening range approximately 1,850 F.

Molybdenum high-speed steels will take all the special surface treatments including nitriding by immersion in molten cyanide that are applied to tungsten high-speed steels for certain applications.

When borax and boric acid are used in a furnace with a silicon-carbide bottom, it is necessary to use a metal pan preferably of stainless iron to prevent the borax from fusing with the silicon-carbide. Such fusion produces a glass-like insoluble coating on the tool which is impossible to remove without damage to the cutting edge.

FURNACES

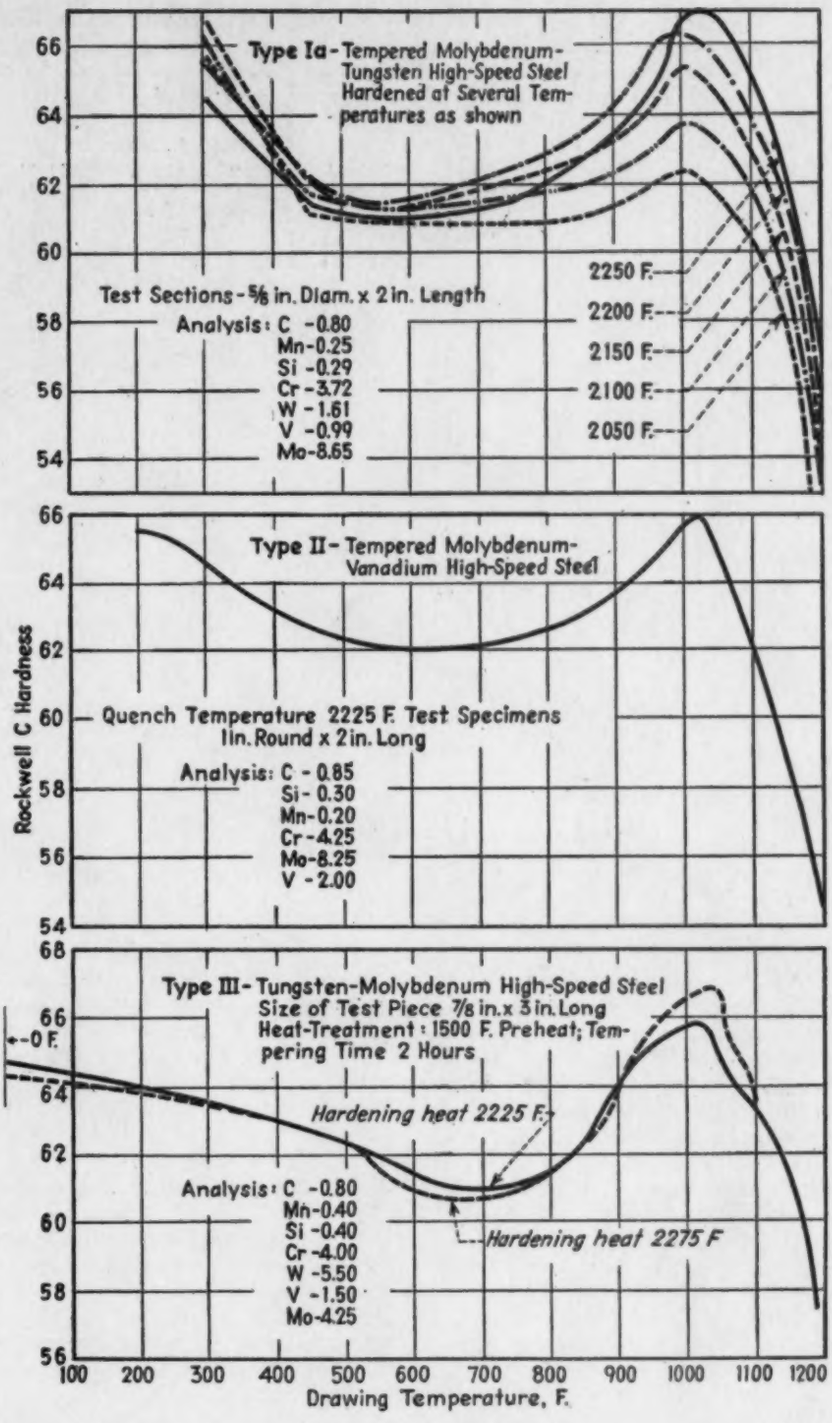
Because molybdenum high-speed steels decarburize when heated, the conventional type furnaces are not satisfactory for hardening. The electric salt bath method when properly controlled eliminates this decarburization and is satisfactory for all types of molybdenum high-speed steels.

In general, immersed electrode furnaces are being used where there is sufficient production to keep furnaces operating at a reasonable capacity.

The following equipment is recommended:

For heavy production and constant use, three-pot unit consisting of (*a*) immersed electrode salt bath preheat furnace; (*b*) immersed electrode salt bath high-heat furnace or (*c*) immersed electrode salt bath quench furnace. For extremely heavy production or large or intricate sections, two preheats are advantageous; the first to be operated at 1,100–1,300 F. and the second one at 1,500–1,600 F.

For medium or light production, but used intermittently, select a three pot unit consisting of (*a*) gas or oil heated salt bath preheat furnace; (*b*) immersed electrode salt bath high-heat furnace; (*c*) gas or oil-heated salt bath quench furnace.


Type Ia - Tempered Molybdenum-Tungsten High-Speed Steel Hardened at Several Temperatures as shown
Test Sections - 5/8 in. Diam. x 2 in. Length
Analysis: C - 0.80
Mn - 0.25
Si - 0.29
Cr - 3.72
W - 1.61
V - 0.99
Mo - 8.65
2250 F.
2200 F.
2150 F.
2100 F.
2050 F.
Type II - Tempered Molybdenum-Vanadium High-Speed Steel
Quench Temperature 2225 F. Test Specimens 1 in. Round x 2 in. Long
Analysis: C - 0.85
Si - 0.30
Mn - 0.20
Cr - 4.25
Mo - 8.25
V - 2.00
Type III - Tungsten-Molybdenum High-Speed Steel
Size of Test Piece 7/8 in. x 3 in. Long
Heat-Treatment: 1500 F. Preheat; Tempering Time 2 Hours
←0 F.
Hardening heat 2225 F.
Hardening heat 2275 F
Analysis: C - 0.80
Mn - 0.40
Si - 0.40
Cr - 4.00
W - 5.50
V - 1.50
Mo - 4.25
Rockwell C Hardness
Drawing Temperature, F.

Salt-Bath Hardening

Decarburization or pitting in the high-heat salt bath is usually caused by the presence of oxides. However, the manufacturers of salt baths supply a neutral bath containing a suitable deoxidizer or rectifier for the bath, which is sufficient to keep it free from oxides under normal operating conditions.

Under abnormal operating conditions where a sufficient amount of new salt has not been added, it becomes necessary to make supplementary additions of rectifier material supplied by the manufacturer. These manufacturers will supply information as to procedure for simple chemical control to maintain the salt bath in a suitable condition.

When a refractory or brick-lined pot is used there is less tendency for formation of oxides in the bath.

Procedure for Salt Bath Hardening

Briefly, the procedure for salt bath

Table 14—SPEEDS AND FEEDS FOR SAE STEELS†

Steel	Depth of cut, in.	High-Speed Steel				Stellite J-Metal**				Cemented Carbides	
		Feeds, in per revolution									
		1/64	1/32	1/16	3/32	1/64	1/32	1/16	3/32	1/64	1/32
		Surface speed, ft. per min.									
Group 1	1/32	100–161	86–138	70–113	60–97	153–246	132–212	114–184	100–161	391–630	357–575
	1/16	91–147	80–138	67–108	57–92	140–225	122–195	106–170	93–150	371–597	329–530
	1/8	81–131	71–115	61– 91	51–83	126–201	110–177	94–152	84–136	341–552	300–530
	1/4	67–108	60– 96	51– 83	43–69	106–170	93–150	78–117	69–110	314–505	266–428
	1/2	47– 76	43– 69	39– 62	31–51	77–124	69–110	59– 94	50– 80	226–363	214–345
Group 2	1/32	82– 96	70– 82	57– 67	49–57	125–146	108–126	94–110	82– 96	320–375	292–342
	1/16	75– 88	65– 77	55– 64	47–55	115–134	100–116	87–101	76– 89	304–356	269–315
	1/8	67– 78	58– 68	50– 59	42–49	103–120	90–105	77– 90	69– 80	281–328	246–288
	1/4	55– 64	49– 57	42– 49	35–41	86–101	76– 89	64– 75	56– 66	257–301	217–255
	1/2	39– 45	35– 41	32– 37	26–30	63– 74	56– 66	48– 56	41– 56	185–216	175–205
Group 3	1/32	67– 78	57– 63	47– 54	40–47	102–119	87–102	76– 89	67– 78	260–304	238–277
	1/16	61– 71	53– 62	45– 52	38–44	93–109	81– 94	70– 82	62– 72	247–288	219–255
	1/8	54– 63	48– 55	41– 48	34–40	84– 98	73– 85	63– 73	56– 65	228–266	2t0–233
	1/4	45– 52	40– 47	34– 40	28–33	70– 82	62– 72	52– 61	46– 53	209–244	177–203
	1/2	31– 37	28– 33	26– 30	21–24	51– 60	46– 53	39– 45	33– 39	150–175	142–166
Group 4	1/32	48– 64	41 –55	34– 45	29–38	74– 97	63– 84	55– 73	48– 64	189–248	172–238
	1/16	44– 58	39– 51	32– 43	28–36	68– 89	59– 77	51– 67	45– 59	179–236	159–210
	1/8	39– 52	35– 45	30– 39	25–33	61– 80	53– 70	46– 60	41– 54	166–218	145–191
	1/4	32– 43	29– 38	25– 33	21–27	51– 67	45– 59	38– 50	33– 44	152–200	128–169
	1/2	23– 30	21– 27	19– 25	15–20	37– 49	33– 44	28– 37	24– 32	109–144	103–137

Group 1—High speeds for SAE X1112; intermediate speeds for 1112, X1314, X1315; low speeds for 1115.

Group 2—High speeds for X1015 and X1020; intermediate speeds for X1330, 2015, 2115, 1010, 1015, 1020, 1025, 1045*, X1335, 3115, 3120, 3130*, 4815, 4820, 6130*, 1030, 1035, 1050*, X1340, 2330*, 2335*, 3135*, 5140*, 6140*; low speeds for X1025, 2315, 3140*, X4130, 4140*, 4615, 4620, 6135*.

Group 3—High speeds for 1040, X3140*, 3145*, 3215, 3220, 3415; intermediate speeds for 3150*, 3312, 4150*, X4340*, 4640*, 5120, 5150*, 6135*, 6150*, 1045, 2340*, 3130, 3240*, X4340, 4640; low speeds for 1050, 2330, 3135, 6135.

Group 4—1055*, 1060*, 1065*, 2345*, 2515, 3140, 3150*, 6150; intermediate speeds for X1065*, 1070*, 1075*, 1080*, 1330, 1335, 1340, 2340, X3140, 3150, 3240*, 3245*, 3250*, 9250*, 1085*, 1090*, 1095*, 3240, 3245, 3250, 9250; low speeds for 52100*.

*Annealed steels.

†Data are for continuous cutting with lubricant.

**With stellite "2400" these speeds can be increased 25–30 percent.

Note: For continuous cuts without lubricant, decrease speeds 25 percent; for intermittent cuts with lubricant, decrease cutting speeds 15 percent; for intermittent cuts without lubricant, decrease cutting speeds 40 percent; for light finishing cuts and fine feeds, cutting speeds can be increased 50 to 100 percent.

hardening can be outlined as follows:

1. Clean work free from scale, rust, oil, grease and moisture. Use either solvent degreaser or suitable alkaline cleaner, followed by a clean hot water rinse, and thorough drying. Every precaution must be taken to prevent moisture on tools going into the salt, as wet tools may cause a steam explosion, burning the operator.

2. Immerse in preheat salt bath at a temperature of 1,500–1,550 F. Allow sufficient time for work to reach temperature of bath.

3. Transfer to high-heat salt bath at a temperature of 2,150–2,250 F. Allow sufficient time for work to reach temperature of bath, plus proper soaking time at temperature.

4. Transfer to quench bath at a temperature of 1,100–1,200 F. Allow sufficient time to cool to bath temperature. Two to five minutes will suffice, depending upon size. Remove from salt bath and cool in air or oil. Quenching in oil is not recommended for work of intricate design or work where distortion is apt to occur.

5. After work has cooled to *room temperature*, wash off all adhering salts in a hot alkaline cleaner. If the work is to be tempered in a furnace (air atmosphere), the work should be shot or sand-blasted or cleaned by other methods, to insure removal of all adhering salts. If this is not done, the salt will attack the work during the tempering. If a salt bath is used for tempering, the work need only be cleaned in a hot alkaline solution or hot water.

Effects of Salt Bath Hardening are as follows:

1. The molybdenum high-speed steels when hardened in salt baths are entirely surrounded by neutral molten salt. A salt film is retained on the tool throughout the hardening procedure, thus preventing decarburization or scaling.

2. The salt bath hardening method provides uniform heating; and this generally results in less distortion. All sections of intricately shaped tools are uniformly heated by this method. The salt bath permits selective hardening.

3. When a salt bath is properly selected and properly maintained, there is no chemical attack by this bath on the molybdenum high-speed steels. The original surface of the steel is retained.

4. Molybdenum high-speed steels will take all the special surface treatments that are applied to tungsten high-speed steels.

Control-Atmosphere Furnaces

In addition to the application of protective coatings when conventional type furnaces are used, and also the use of high temperature salt baths, atmosphere controlled furnaces satisfy this demand for surface protection against attack. These furnaces are available in both electric and fuel-fired types where the atmosphere is independent of the source of heat.

MACHINING

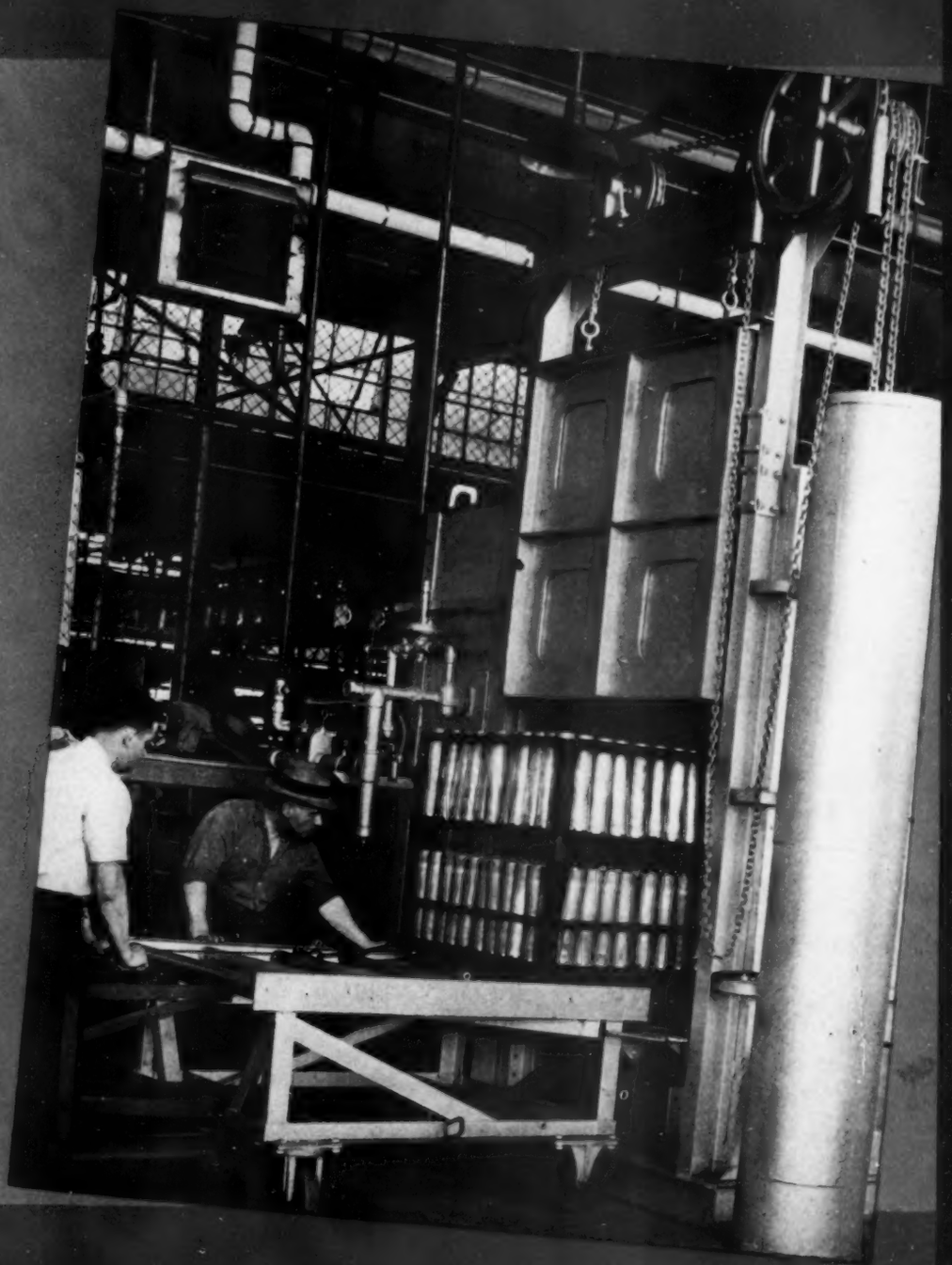
Data on machining the steels discussed in this article will be found in "The Working of S.A.E. Nickel Alloy Steels," (*AM*—Vol. 83, page 865), and "The Working of High-Speed Steels," (*AM*—Vol. 84, page 93). Cutting tool angles, as well as speeds and feeds for machining, drilling, tapping, threading are given. Recommended coolants for all types of machine work are listed, as are types of grinding wheels and speeds. Table 14 covers steels not included in the first of the above articles, and compares speeds when cutting the alternate steels.

The machining of molybdenum high-speed steels is covered in the second of the above mentioned articles.

Armament

SECTION OF AMERICAN MACHINIST

SHELL CASES MADE IN CANADA



also **Machine Production of Plane Ribs**

SHELL CASES MADE IN CANADA

UPON COMPLETION of a contract for brass cartridge cases for 3.45-in. smoke shell, a Canadian plant retooled for production of American 75-mm. cases for the British government. The similarity of the two cases in respect to diameter permitted the press and furnace equipment to be used with few alterations, but the greater length of the 75-mm. case required ingenuity to fit tools in the "daylight" available on the re-drawing presses. The greater length of the 75-mm. case also threw production of the various machines somewhat out of balance. Nevertheless, the department is capable of an output of approximately 600 cases per hour—a production level which will probably be of interest to many American plants which can set up shell-case lines within their confines.

The Frankford Arsenal has worked out methods in great detail for the production of 75-mm. shell cases and the Arsenal method has served as a pattern to American industry. Nevertheless, the practices of the Canadian plant are timely because they represent the commercial approach to an output of the stated level, certain ideas in tooling have been developed, and it is possible to show the work flow through the department.

The differences between practice at the Frankford Arsenal and the "commercial" approach at the Canadian plant are as follows:

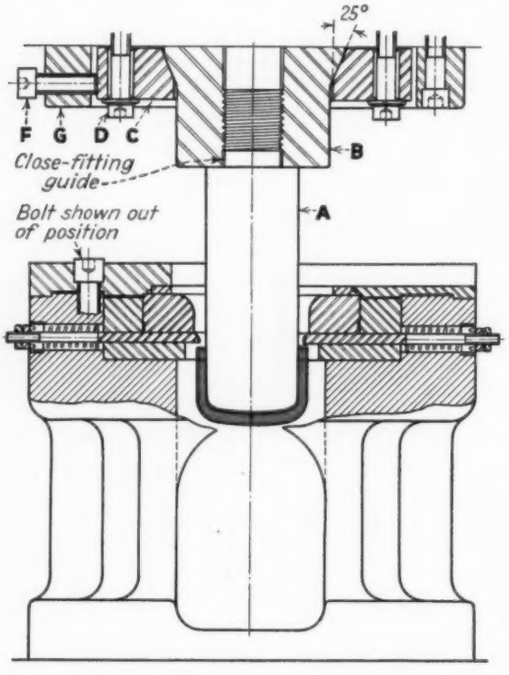
1. Four drawing operations are used by the Canadian plant instead of three, at the order of the British War Department.

2. Reductions at successive stages are correspondingly less severe. The following data show the reduction of metal thickness at bottom of side wall and at top of the case compared to the previous operation.

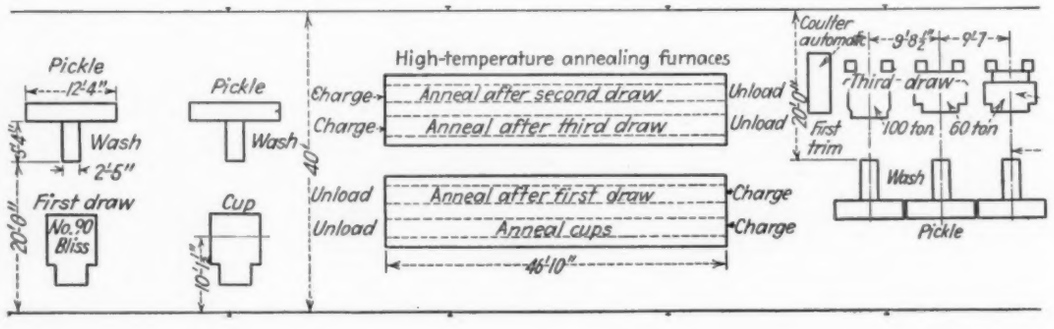
	FRANKFORD ARSENAL	CANADIAN PLANT
	First Draw	
Reduction at Bottom	35%	
Reduction at Top	60%	55.7%
Length of Case	5.5 In.	
	Second Draw	
Reduction at Bottom	40%	
Reduction at Top	50%	38.1%
Length of Case	9.25 In.	
	Third Draw	
Reduction at Bottom	50%	
Reduction at Top	30%	50.7%
Length of Case	15.5 In.	
	Fourth Draw	
Reduction at Bottom	....	
Reduction at Top	....	15.4%
Length of Case	....	

3. No metallurgical control over grain size is provided. Temperature and time cycle of annealing furnaces are set to provide a grain size satisfactory to government inspectors, and furnace thermocouples are checked monthly with master thermocouples.

4. Three trimming operations are employed instead of two. The first trimming operation is performed after the second draw, not the third, in order to give a square surface for stripping against the lower edge of the draw ring in the third drawing operation. Drawing fingers are no longer used in connection with the drawing dies. The punch travel



No serrations are employed on the bottom of the cupping punch, the radius being sufficient to retain enough metal in the head for the heading operation. The punch is held in a hardened and ground adjustable retainer to prevent cocking and to facilitate alignment



With the layout shown, a unit department to produce approximately 600 cartridge cases per hour can be fitted into existing space, or rearranged to suit. The equipment shown here is not in exact production balance because it was previously employed for manufacture of a shorter case

has been shortened to suit the daylight of the presses available. Hence, a ragged edge of a case may not clear one of the fingers, that finger digs into the soft metal and tool breakage results. Trimming at this stage minimizes scrap from split or deformed cases to a negligible amount.

The second trim occurs after the fourth draw, to provide a square edge for the tapering operation, and is done on a hand-fed spindle, not an automatic set-up as at the Arsenal. The third trim is combined with machining the head on a Bullard special lathe.

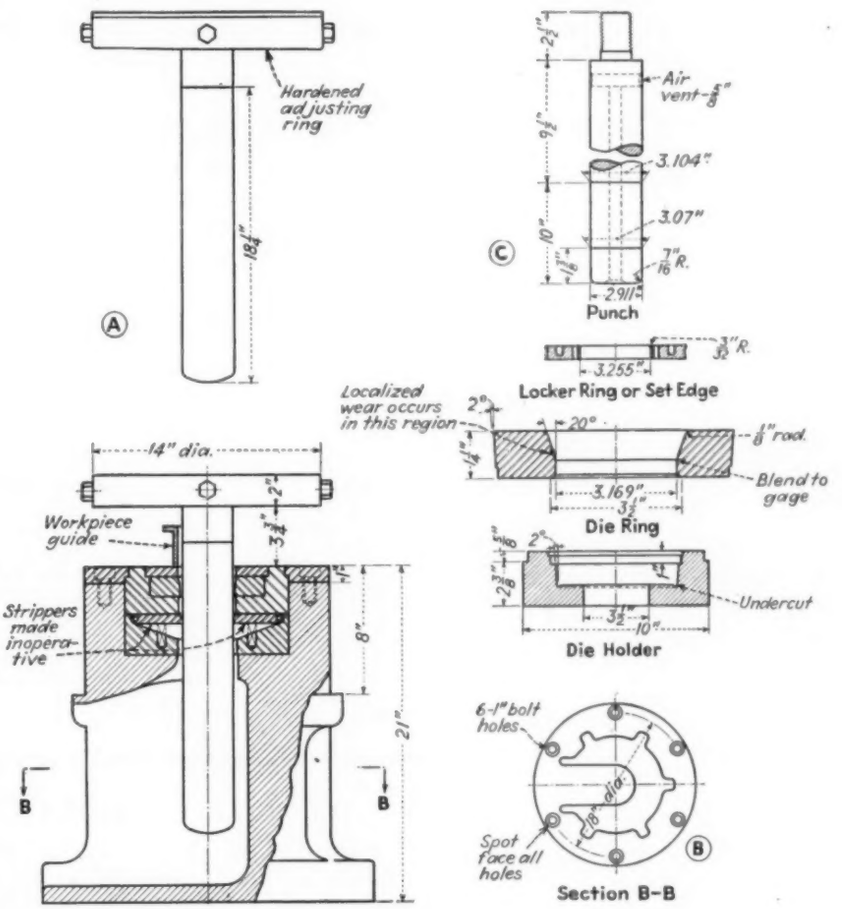
5. Tool design shows some changes from Arsenal practice. In the first place no dial feeds are employed. All drawing presses are equipped with a simple hand-operated slide feed. Work comes to the operator on an inclined wooden trough. Cases ejected from the die fall down a chute into a rinse tank, from which a helper removes them to a box truck for transfer to the annealing furnace or the next operation.

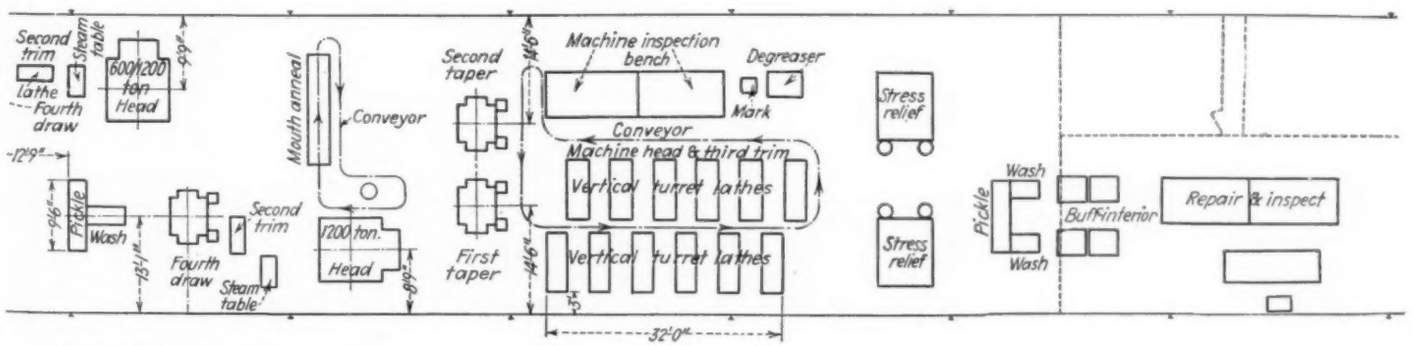
The cupping and drawing punches are not serrated on the bottom as in Arsenal practice. The punch is merely radiused to set the metal down hard at the corners of the cup and sufficient metal is retained in the base to head without indenting. A tit on the punch center line keeps the blank from sliding. An important development is that of mounting the punch in a hardened adjustable retainer, which has overcome trouble from the punch cocking, reduces set-up time, and provides better alignment. As shown in the cupping die layout, the punch *A* is threaded into the hardened retainer *B* and it must be a close fit in the retainer to secure the desirable degree of alignment. The retainer is held by a tapered collar *C*, which is fastened to the press ram with six locking bolts *D* passing through oversize holes in the collar. Adjustment of the retaining ring on the face of the ram is provided by four adjusting screws *F* in the adjusting ring *G*, which is bolted firmly to the face of the ram. It will be noticed that the bearing surface of the punch retainer against the ram is much larger in area than the cross-sectional area of the punch, so as to distribute the pressure. All parts of the punch retaining device are hardened and ground to close limits. The greater expense of this construction has paid for itself many times over in reduced punch wear and maintenance. Drawing punches are held in the same type of retainer.

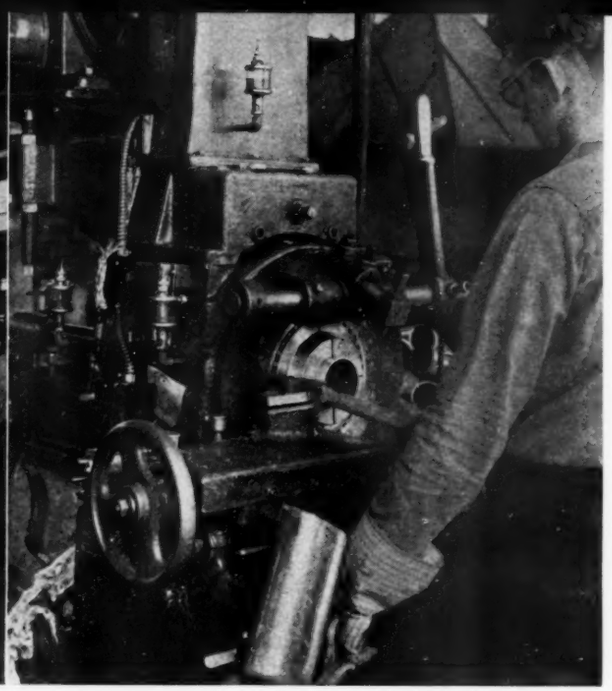
The drawing dies used in Canada show other variations from the Arsenal method. Draw rings are made of water-hardening high-carbon steel instead of cemented carbide, and have given satisfactory service on production contracts, besides being much easier and cheaper to obtain in the Dominion. A lighter draw ring is used, and it has a 2-deg. taper on the outside diameter. The taper acts to hold the draw ring in place in the alloy steel holder against stripping pressure, but makes it easy to remove the draw ring.

Inside of a continuous curvature in the

A double-angle draw ring with the drawing radius developed to suit the job is employed for all drawing operations. Strippers are not used on drawing dies, because with limited punch stroke there is a possibility that a ragged edge would not clear the strippers and jamming would result







Charging and delivery ends of the two Holcroft pusher-type furnaces are arranged to prevent mix-ups of work-hardened and annealed pieces. A pneumatic hoist and time-clock operated doors save effort

Above right—The first trim is performed after the second drawing operation in order to square up the case for the third draw and minimize cases damaged in stripping. Trimming is a high-speed operation on this Coulter machine, which has a pedal-operated chuck and a hand-operated cutting-off tool slide

mouth of the draw ring, double-angle construction is employed to facilitate grinding. The mouth of the draw ring has a 15-20 deg. angle, according to the operation, a radius at the drawing edge developed for the given operation and a straight throat, which is approximately ½ in. deep when the draw ring is new. Wear occurs in the region above the radius, and is removed by a simple grinding operation. The radius itself is dressed to a templet. Blending of the radius with the straight surfaces is extremely important. The amount of reduction and hardness of the wall of the shell case are controlled by the drawing radius. It is of particular importance in the last, or fourth, draw to obtain the desired hardness at the lower portion of the side wall and leave enough metal in the head for the heading operation.

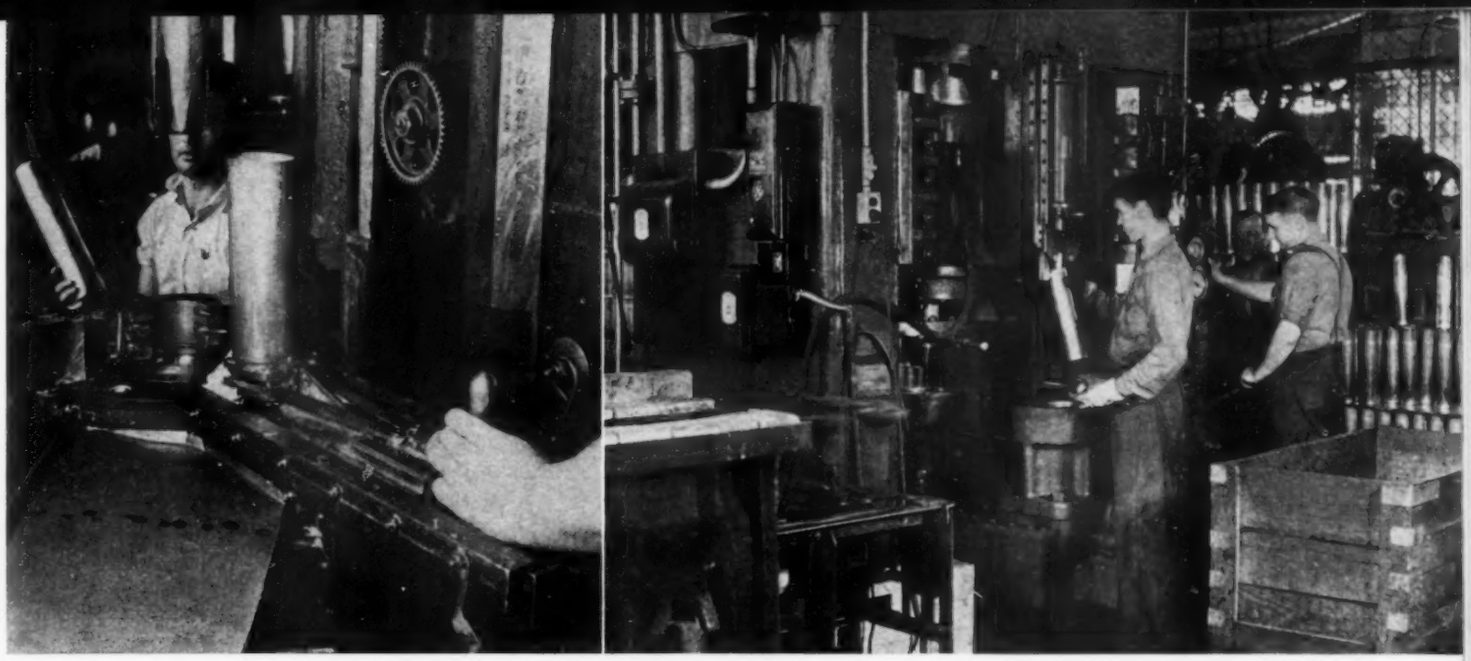
The alloy-steel holder is a close fit in the bolster and is held on the shoulder by a clamp ring fastened to the bolster with screws. The draw ring itself depends largely upon the press fit for retention in the holder, but a "set-edge" ring is screwed into the holder and down onto the draw ring for additional security, and also to act as a guide for the partially drawn case.

A unit department for production of 75-mm. cartridge cases at the rate of 600 or more per hour with 135 operators can be laid out in a space of 40 × 330 ft., if the Canadian method is followed. Additional space is needed for receiving and shipping rooms and for government inspection. The layout shown has plenty of space for truck transit and storage work between operations. A normal float consists of about 25,000 pieces in various stages of manufacture.

Cartridge-brass disks blanked to 5.50-in. diameter from 0.450-in. stock are received in the area adjacent to the two Bliss No. 90 crank presses, which are utilized for cupping, first draw and second draw. Two Holcroft pusher-type double-row annealing furnaces are located between the mechanical presses and the hydraulic presses, the latter being reserved for the third and fourth drawing operations. Work flow from the presses to annealing and thence to the next operation is

OPERATIONS SHEET

NO.	OPERATION	MACHINE USED	PRODUCTION
1	Cupping	Bliss No. 90 440-ton crank press	600 per hr.
2	Anneal & Cool	Holcroft pusher furnace	
3	Pickle & Wash	Lead-lined acid tank Counter flow wooden rinse tank No baskets	
4	First Draw	Bliss No. 90 440-ton crank press	600 per hr.
5	Anneal & Cool	Holcroft pusher furnace, same as operation No. 2	
6	Pickle & Wash		
7	Second Draw	Bliss No. 90 440-ton crank press	600 per hr.
8	First Trim	Coulter special trimming machine	600 per hr. plus
9	Anneal & Cool	Holcroft pusher furnace	
10	Pickle & Wash		
11	Third Draw	Dominion Engineering 100-ton hydraulic press Dominion Engineering 60-ton hydraulic press	350 per hr. 350 per hr.
12	Anneal & Cool	Holcroft pusher furnace, same as operation No. 8	
13	Pickle & Wash		
14	Fourth Draw	Two Dominion 60-ton hydraulic presses	350 per hr. each
15	Second Trim	Hand-fed trimming spindle	



A simple slide feed is employed on all drawing operations. The main slide incorporates a top slide (with handle) having a slight movement, which is sufficient to close the fulcrumed jaws around the case. A stop behind the die opening prevents the case from tipping as it drops into the cavity when the handle is pulled back and the jaws are released

Above left—Heading is performed upon a two-station Dominion 1,200-ton hydraulic press. The pneumatically operated stripper has just removed a headed case from the front bolster, while the ram is heading the case in the rear bolster

such that mix-ups of work-hardened and annealed work are avoided. For example, cups dropping out of the bolster are rinsed and dropped into box trucks, then transported to the charging end of the first annealing furnace. Here the pieces are loaded into trays and pushed through the furnace toward the machanical-press department. After cooling in a water quench, the annealed cups are trucked to a storage area in front of the pickle tank serving the first-drawing press. After the first draw, the work-hardened parts are again trucked to the charging end of the first annealing furnace, but pushed through on the other track. Cooled parts are taken to the storage area serving whichever of the two Bliss presses is currently working upon the second drawing operation. The two crank presses, rated at 960 strokes per hour, are fast enough to handle all three operations—cupping, first and second draws—with tool changes at proper intervals.

After the second draw, the work is annealed in the second furnace and then stored in the area near the hydraulic third-draw press. To anneal cases after the third drawing operation, the cases are again sent through the second annealing furnace, but on the other track, and trucked to the fourth-draw presses.

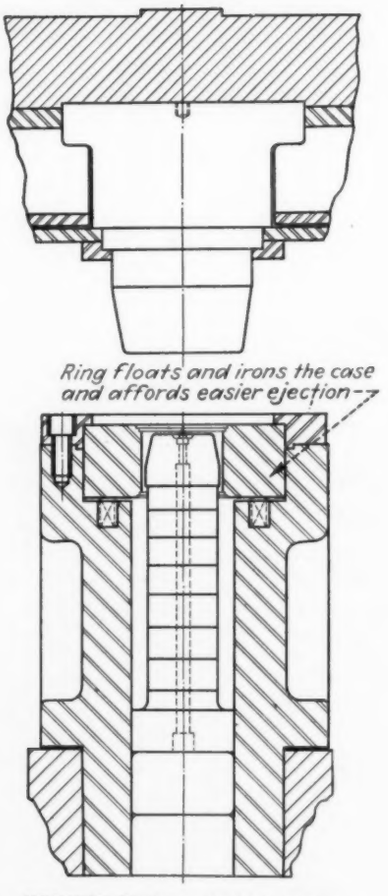
The time-temperature cycles of these two furnaces are preset to achieve grain-size and hardness control by means of samples satisfactory to government inspectors, and no metallurgical tests are made by the shop. In the first furnace, which anneals after the cupping and the first drawing operations, the metal is restored to the original hardness of the blank—60-70 Vickers diamond Brinell with a 10-kg. load. The temperature is maintained at 1,250 F. and the work is in the furnace for 1 hr. But annealing after the second and third draws is arranged to bring only the wall of the case, not the head, back to the original metal hardness. Therefore the work remains in the furnace for only 36 min. at 1,265 F. Controlled atmosphere is not required.

One pickling tank and one rinse tank are arranged in front of all draw presses. The work is not pickled until intended for im-

OPERATIONS SHEET

NO.	OPERATION	MACHINE USED	PRODUCTION
16	Steam clean interior	Home-made fixtures	
17	Heading	Two Dominion 1,200-ton hydraulic presses	
18	Mouth Anneal	Home-made gas furnace	700 per hr.
19	First taper	Dominion 60-ton hydraulic press	550 per hr.
20	Second taper	Dominion 60-ton hydraulic press	550 per hr.
21	Finish machine head and primer hole and final trim to length	Twelve Bullard special turret lathes	45 per hr. each
22	Inspection of machining		
23	Stamp identification, except lot number	Noble & Westbrook marking machine	600 per hr.
24	Degrease	Canadian Hanson-Munning conveyorized degreaser	
25	Stress-relief anneal	Two Surface-Combustion gas-fired car-type furnaces	450 each per hr.
26	Pickle & Wash	Lead lined and wooden tanks	
27	Clean interior	Buffing spindles	
28	Final Inspection and repair		
29	Stamp lot number		

Cases are tapered in two operations to prevent overworking the metal and to reduce scrap. The operator inserts the mouth-annealed case in the dies fixed to the ram and the head is caused to strike the bolster sharply. The operation is performed on a high-speed Dominion 60-ton hydraulic press



HEADING TOOLING ARRANGEMENT

An indenting plug is used in the heading tools, similar to American practice, but the die ring floats to iron the case and afford easier ejection from the die

mediate use in order to avoid carrying dirt or grit into the dies. Cases remain in a 9 percent sulphuric acid solution for about 15 min., are then transferred to a counter-flow cold-water rinse tank, and finally placed in a wooden chute leading to the press operator. This system of pickling and rinsing cases is considerably more simple than that employed by the Arsenal method.

Work falling out of the press bolster drops into a small rinse tank in order to remove the drawing compound. The cases are not washed a second time before annealing.

Reference to the "Operation Sheet" will disclose the exact sequence of operations up to the point of performing the third draw. This operation is carried out on the equipment available from the 3.45 in. cartridge-case set-up — namely a 100-ton Dominion hydraulic press which had to be modified to secure the 53 in. of daylight required, and a 60-ton Dominion hydraulic press with 72 in. of daylight. Construction of the punches and dies by the principles outlined has saved 2 in. of punch travel on this operation. The drawing speed on this operation is 17½ ft. per min. This speed is "low", but the shop would not care to go above 23 ft. per min. in order to avoid lubrication problems and "on the nose" annealing. Production per press runs approximately 350 cases per hour, so that the output of the two machines is more than sufficient to carry the production load of the shop. An operator cannot handle many more than 400 cases per hour without mechanical feeds. Besides, at high drawing speeds per minute, power consumption rises sharply, the press must be larger and more expensive, and a furnace tied in the drawing operation and maintained in perfect heat balance would be required.

The same drawing speed, 17½ ft. per min., is used for the fourth drawing operation, which is carried out on two 60-ton Dominion hydraulic presses. In this operation the radius in the mouth of the draw ring is of maximum importance in order to secure the final hardness desired near the bottom of the side wall and yet not thin the metal excessively nor split the case. Proof checks of the hardness are made twice daily by the inspectors.

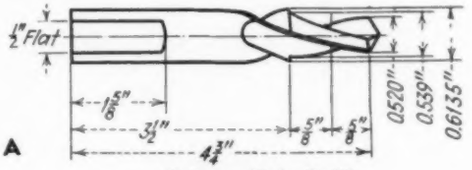
Before heading, the case receives its second trim, which is required prior to tapering the mouth. Trimming is carried out upon a simple arbor. The operator merely slips the case onto the arbor and holds it there with the pressure of his gloved hand while the pedal-operated trimming slide advances to the work. The length of the case is established by the arbor bottoming in the cavity. Production on this operation can exceed 400 per hour.

SHELL CASES MADE IN CANADA

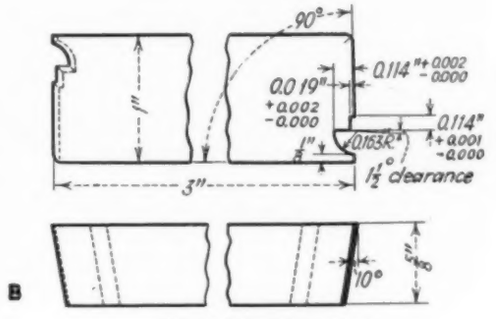
The trimming-machine operator passes the case to the steam-cleaning table. The case is placed down over a vertical pipe having orifices to direct steam into the cavity. Live steam applied in this manner removes all traces of grease or oil from the interior of the case and leaves the metal in the bright condition. If a smooth bright surface is not obtained prior to heading, a granular appearance may be caused by the grease or oil adhering to the metal and the inspector may confuse this condition with the annular ring produced by a fold or crack resulting from imperfectly fitting punches. Steam cleaning thus saves arguments and polishing of the metal, and is considered better and faster than degreasing. The process also takes out foreign matter that might cause trouble in the heading tools.

Heading is carried out on a two-station Dominion 1,200-ton hydraulic press. The heading pressure is approximately 900 tons, and the hardness produced ranges from 135-140 Vickers diamond Brinell at the primer hole to 170 at the outer edge. A three-man crew operates the press—an operator at the controls, and two helpers loading and unloading the work. Two bolsters are mounted on a power-operated carriage that moves from the front to the back of the press on ways. If the helper at the front of the press is removing a headed case from the pneumatically operated stripper and placing a new case, the rear bolster is under the heading ram. When the controls are again thrown, the carriage moves to the rear of the press, where the second helper removes the headed work and inserts a new piece in the dies while the case in the front bolster is being headed. Operators place headed cases on the conveyor serving the mouth-anneal furnace.

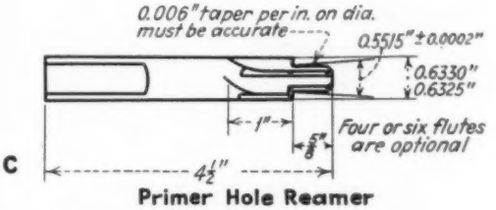
The home-made mouth-anneal furnace has attracted considerable attention because of the simplicity of its operation and the uniformity of results attained. The conveyor



Primer Hole Drill



Head Forming Tool



Primer Hole Reamer

High-speed steel tools developed by the Harrington Tool & Die Co., Montreal, are employed to machine the head and primer hole. It has been found unnecessary to use a second reaming of the primer hole to attain the accuracy required for a press fit with the primer

In four operations, the head is machined, the primer hole is drilled and reamed and the tapered case is trimmed to length on a special Bullard shell-case hand-turret lathe. For cases requiring tapping of the primer hole, an additional tool can be placed in the turret

All identification, except the lot number, is stamped on the head with a Noble & Westbrook marking machine. The case is slipped mouth-end down over a post, which is swung out for the purpose, and then pushed under the hand-operated marking die

transports the cases, mouth end up, through a brickwork tunnel with burners firing from both sides. The burners are arranged in horizontal rows with the flames adjusted to produce a variable temper, the case being left hard at the bottom and gradually increasing in softness toward the top. The desired degree of hardness is attained by adjusting gas-manifold pressures and the speed of the conveyor. The equipment is regulated to maintain a hardness at the mouth of 70-75 Vickers diamond Brinell *after* the tapering operation. A water-spray cabinet at the end of the furnace accelerates cooling, and the conveyor loop acts as storage medium for the tapering operation. No labor is required to operate the mouth-anneal furnace, which has a capacity of 700 cases per hour. Gas annealing in this manner avoids the several washes required after the salt-bath method of mouth annealing.

Tapering is done in two stages to ease the strain set up in the metal and to reduce scrap. The first operation "leads in" the metal at the mouth so that the case can be tapered complete in the second operation. Production from each press equals 550 cases per hour. The 60-ton presses have the same rating and

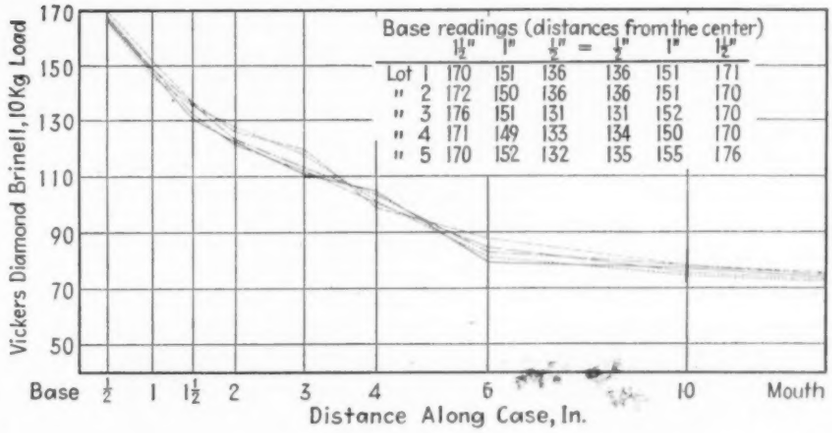
Stress-relieved cases are pickled and washed, then buffed on the interior to a bright clean surface for the benefit of government inspectors. Five parts sawdust and one part sand are employed at each of the two buffing operations, after which the case is blown out with compressed air

Dents or an out-of-round condition of the mouth are corrected in the repair department, which is a part of final inspection with chamber gages. By not putting the lot number on the case until after these operations, a batch is not held up in going to the government inspection station

daylight specifications as the drawing presses and can serve as reserve equipment in case of damage to the redrawing equipment. The tools used on this operation are similar to those employed by Frankford Arsenal.

A battery of special Bullard turrent lathes is employed to machine the head and primer hole, and to trim the case to final length. This type of equipment can also be used to tap the primer hole in cartridge cases requiring that operation. The operator first drills the primer hole, using the tool in the first turret hole. The turret is backed out and indexed, and the cross-slide with box-toolholder is advanced to face the head and form the outside diameter. Two tools are fitted to the toolholder, a square facing tool and the form tool. The turret is again advanced to ream the primer hole in one operation, using either a four-flute or six-flute reamer. While the operator sands the face of the head, he operates the trimming slide behind the headstock to trim the case to final length. Production averages 45 cases per hour on this type of equipment.

At this point 100 percent inspection is introduced to catch errors, particularly in machining. Each Bullard operator is required to crayon his number inside the case, and imperfect work is immediately traced to the machine giving trouble. Cases that pass inspection are stamped with all identifying data except the lot number. A Noble & Westbrook marking machine is used for the purpose. The lot number is not put on the case until it is ready for government inspection.



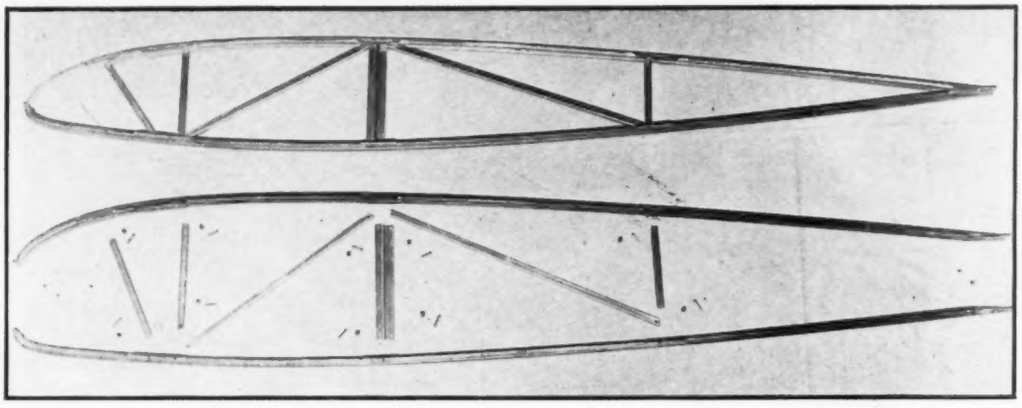
These Vickers diamond Brinell hardnesses along the cartridge cases indicate the hardness regularity obtained. The curves represent readings from each of five lots taken by the inspector before the cases were sent for firing proof

Final degreasing before stress relieving has been done in a hand-dip tank, but this equipment is being replaced with a conveyor-type machine. Clean cases are loaded into racks and charged into a double-ended Surface Combustion convection-type car furnace for stress relieving for 1 hr. at 540 F. Each charge comprises 450 cases. The double-door construction of the furnace avoids idle time. An identical furnace provides extra capacity. Final operations on the case include pickling and washing, polishing the interior on buffing wheels, and repair of dents or an out-of-round condition of the mouth if needed.

Machine Production of Plane Ribs

BY W. E. HIRTENSTEINER,
Vice-President in Charge of Engineering, Interstate Aircraft & Engineering Corporation

Many members for the 52 ribs used in "Cadet" planes are interchangeable. This standardization has permitted development of special presses and punches, simplified assembly methods, and has resulted in decreased manufacturing costs

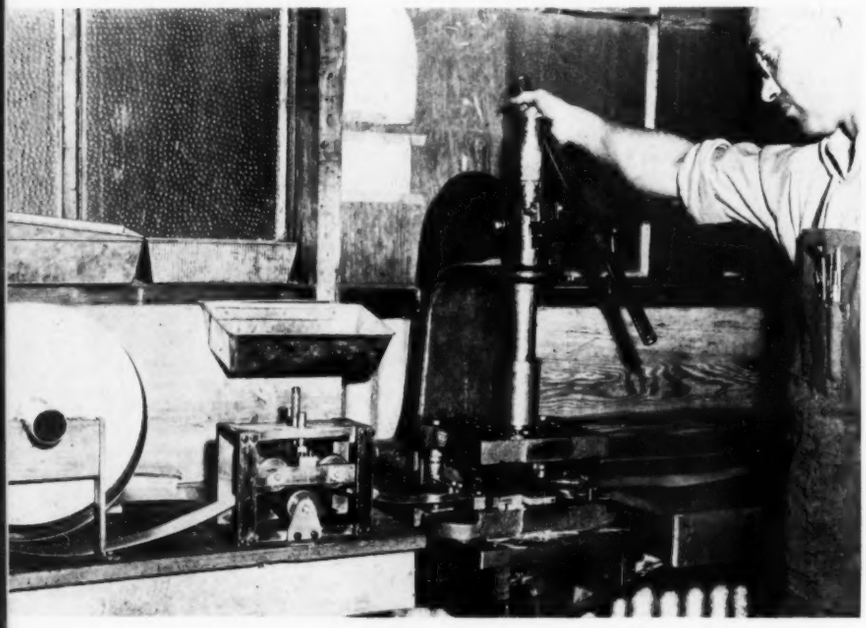


The Cadet has ten types of ribs, each with the same basic dimensions. All internal bracing for the 52 ribs used is interchangeable. This standardization has reduced manufacturing costs

LIGHT AIRPLANES are now widely used for training pilots of our armed forces, for military reconnoissance and by civilians in many walks of life. Extensive tooling, efficient production procedure and highly trained personnel are responsible for these advances. Special tooling has been designed and built to do jobs that heretofore have added costly manhours to the price of an airplane. One outstanding example of this is the rib construction incorporated in the Interstate Cadet.

All parts in the rib are made from 0.020-in. dural and are processed in a few simple operations. By purchasing aluminum coil strip stock, held to close tolerances, the usual procedure of shearing large sheets into the desired widths is eliminated. This assures a constant width of the coil stock within a few thousandths of an inch and guarantees positive action by the dies and various tools through which material is processed. It also eliminates the trimming so often necessary with material that is not held to close tolerances. Alclad 24ST is used in the fabrication of all parts for the ribs except the capstrips which are formed by a hydraulic press from 24SO and then heat-treated. The only deviation from the 0.020-in. thickness is found in the aileron hinge plates which are made from 0.063-in. sheet stock and $\frac{1}{4}$x$\frac{3}{8}$-in. dural bars.

All rib stock is sheared to length and exact end pattern in arbor presses. It is fed from the coil over straightening rollers and under the die where automatic stops permit precision shearing to fourteen lengths



Multiple Patterns from One Die

A small hand-operated arbor press starts the flow of parts for the rib assembly. The coil stock passes through rollers in a flattening process and continues into the press where it is cut to length and ready for forming by the hydraulic press. A single die accomplishes the various cutoffs necessary in one stroke of the press. Four shearing patterns are possible with the one die, the most intricate being per-

formed on the upper and lower strips which make up the aileron hinge rib. These are sheared on the leading edge and a two-pronged fork section at the trailing edge in such a manner that the rib capstrip is formed to exact specifications by the hydraulic dies, eliminating from 20 to 30 min. of hand trimming per rib. The strips for all ribs are cut to exact lengths with a maximum waste of from ½ to ¾ sq. in. of material for each strip sheared. Fourteen various types and lengths of capstrips are required per ship and all are handled by the one die at an average production rate of from 90 to 150 per hour.

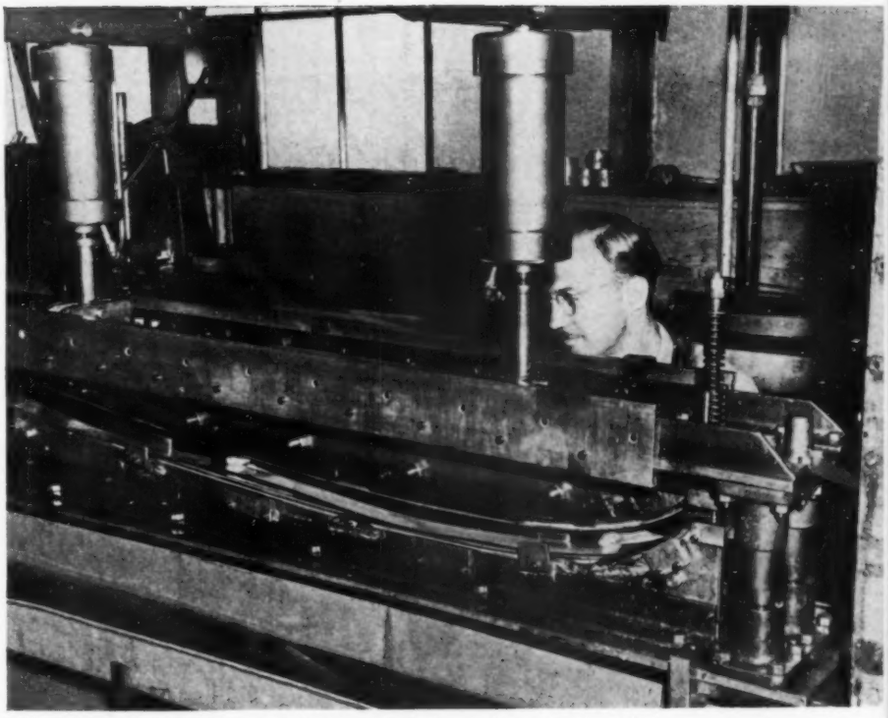
Special Machines Speed Production

One other die completes the fabrication of the internal bracing used in the rib. U-channels and Z-angles, which are formed in fourteen foot lengths by a brake, are punched and sheared to length in a single operation. Development in the shop of a special stop speeds up the rate of production to between 500 and 600 pieces per hour. This operation includes shearing to a length tolerance of 0.010-in. and prepunching for assembly. The final step in preparation of material for rib production is cutting of dural spacers to form a firm seat for the rivets. The spacers are cut to length, drilled and chamfered by an automatic machine at the rate of nine to ten thousand in eight hours.

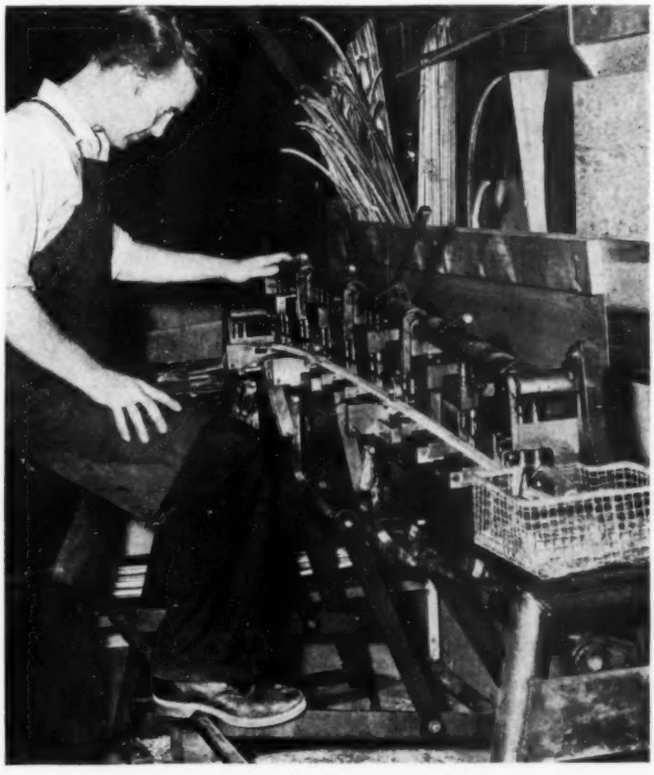
The capstrips form the most unique and practical part of the Cadet rib. They are formed into a hat-shaped section with rolled brims and a bead the length of the crown in a single action by dies under hydraulic pressure. Both the dies and the press were designed and built in the shop to do this particular job efficiently and, as mentioned previously, are co-ordinated with the operations of the arbor press to turn out the various types and lengths to exact contour, shape and dimensions. Two dies are utilized, one for the upper capstrip, the other to press out the lower one. By the careful use of guides and stops, various sections of the dies can be used to produce any section of the air foil desired.

After being heat-treated, all rivet holes are punched in a single operation by a special punch press developed in the shop. This one feature alone makes it possible to construct a rib of exceptional strength and lightness at a low cost. Heretofore, the usual procedure has been to punch one or two holes as indexes and hand drill the remainder. Through the use of a special press it is possible to punch 32 holes (12 horizontal and 20 vertical) with 25-lb. pressure on a foot treadle.

Nearly three months was spent in designing and building this original punch jig. The main problems were to punch 32 lofted holes keeping within a tolerance of from 0.001-in. (in



The capstrips are formed into a hat-shaped section with rolled brims and a bead along the length of the crown in a single action by dies in this hydraulic press. All sections of the air foil are produced with one set of dies



Capstrips are punched with twelve horizontal and twenty vertical holes simultaneously in this punch jig. The punch and dies are adjustable to accommodate seven different sets of dimensions. Tolerance on vertical holes is held to 0.001 inch. Production is 150 capstrips per hour

The top and bottom capstrips, leading edge, spar caps and bracing members of the ribs are jig assembled and held in place with chamfered rivets. Assembly of each rib requires six minutes

The assembled rib remains in the jig for final riveting in this air squeeze operated by a foot treadle. The pull of the riveter is counteracted by the jig. The rib is finished to within 0.010 in. of required size

the case of the vertical punches) to 0.010-in. throughout the contour, maintaining this accuracy while making the punch blocks adjustable to accommodate seven different sets of dimensions, and to decrease the force of 1,950 lb. necessary for all punches to pierce the material to 25 lb. at the foot treadle. All of these were met successfully.

All of this was accomplished in a machine that occupies ten square feet of floor space and can turn out from 100 to 150 capstrips per hour. The increased production in manhours alone amounts to a little over 300 percent.

The punch jig is correlated with the hydraulic press by a mark made on every rib while being formed. The location of this mark on the rib dies is transferred to a corresponding point on the contour of the punch press; thus, absolute uniformity is assured. The consistency of the parts thus produced has shown an added time saving of 40 percent in assembly time.

The 52 ribs and false ribs which make up the Cadet wing are divided into ten types, yet all have the same basic dimensions, with the internal bracings being interchangeable. This standardization of parts makes for simplicity of design and reduction of manufacturing costs.

In the assembly of the rib, the two capstrips are first riveted together at the leading edge and then the three diagonal bracing channels, two spar caps and the Z-angle in the center are pinned in place with chamfered rivets. These are placed in a contour jig and riveted in an air squeeze operated from a foot treadle. In the case of the main wing rib, the assembly time consumes from five to six minutes, the riveting from three to four.

Tolerance on Ribs is 0.010 in.

The assembly jigs are made from 1-in. angle iron with false spars and guides inside and out of the contour of the capstrips. With the precision parts utilized and the slight pull of the riveting process being counteracted by the jigs, the finished rib comes out to size within 0.010 in.

An exclusive patented feature of the Cadet is the use of clips for the fastening of the wing fabric to the ribs. The bead described in the fabrication of the capstrip and punched before assembly completely hides the clip and results in a flat, smooth surface on the wing. The interior of the wing is absolutely free of all the crisscross threads found in rib stitched wings. The method has proved extremely practical in every way and the wing has withstood a number of test dives in excess of 200 miles per hour.

Furnace Refractories—I

BY HENRY C. FISHER, REFRACTORIES ENGINEER, NORTON COMPANY

REFRACTORY PRODUCTS of one kind or another are vital to the satisfactory performance of enameling, heat-treating and annealing furnaces. The builders of these furnaces are familiar with the various kinds of refractory products and with their physical properties. However, the men who are using these furnaces are given little information about the refractories used in their construction or the care that should be given them. The desirable qualities of refractories for the various parts of enameling, heat-treating, and annealing furnaces are outlined.

It is evident that the types of furnaces listed have some common refractory requirements. In all of these furnaces, refractories are wanted which are resistant to deformation at furnace temperatures, resistant to spalling, resistant to oxidation and resistant to abrasion. In some of the furnaces, a maximum of heat insulating properties is required, whereas in others the very opposite, namely, a maximum of heat conductivity in the refractories is wanted.

It is difficult to find one refractory which possesses all of the desired properties and none of the undesirable ones. For example, in the construction of the muffle type of enameling furnace, high heat transfer by the refractory is most desirable. The quantity of heat transferred directly affects the economy of the furnace. According to the accompanying table, silicon carbide refractories possess many of the physical properties of a desirable material for the construction of the muffle. These products have the highest heat transfer value of any of the non-metallic refractory materials. They also are stable under load, are resistant to abrasion, do not react appreciably with ash in the fuel, and are resistant to spalling. A refractory that is resistant to oxidation is also necessary. It is seen that silicon carbide refractories fall far short with respect to this property. The oxidation of silicon carbide would cause disintegration of the refractory and would also cause a lowering of the heat

REFRACTORIES FOR ENAMELING FURNACES

Type of Furnace		*Qualities Desired in Refractories*
Electric and Radiant tube (Maximum temperature — 1,800 F.)		1. Heat insulation 2. Resistance to abrasion where charge may come into contact with refractories 3. Resistance to spalling 4. Resistance to oxidation
Muffle Type, Fuel Fired	A. Muffle (Maximum temperature — 1,800 F.)	1. High heat conductivity 2. Resistance to deformation under load 3. Resistance to abrasion in hearth 4. Resistance to oxidation 5. Muffle bottom of material which does not react with fuel ash 6. Resistance to spalling
	B. Combustion Chamber (Maximum temperature — 2,650 F.)	1. High heat conductivity in muffle bottom 2. Resistance to deformation under load 3. Resistance to spalling 4. Non-reactive with ash in fuel oil 5. Resistance to oxidation

REFRACTORIES FOR HEAT-TREATING AND ANNEALING FURNACES

Type of Furnace	*Qualities Desired in Refractories*
Electric, exposed element, and Radiant Tube	1. Heat insulation 2. Resistance to abrasion in parts that come in contact with charge 3. Resistance to spalling 4. Resistance to oxidation
Electric (Element embedded in wall)	1. Electrical insulation 2. High heat conductivity 3. Resistance to oxidation 4. Resistance to abrasion 5. Moderate degree of refractoriness
Rotary Hearth Fuel Fired 2,400 F. maximum on hearth 2,600–3,000 F. in burner tunnel	1. Highly refractory burner tunnels 2. Abrasion and spall-resistant charging door frame 3. Abrasion resistant and heat insulating hearth 4. Chamber lining of highly refractory spalling resistant brick of low heat transfer value
Stationary Hearth Combustion chamber under hearth Fuel Fired	1. Hearth highly refractory 2. High heat conductivity in hearth 3. Resistance to abrasion 4. Resistance to spalling 5. Non-reactive with iron oxide 6. High refractory non-spalling pier brick

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Furnace Refractories—II

transfer value as oxidation progressed. A second choice of refractory becomes desirable.

The table also shows that bonded fused alumina has a high heat transfer value, although not as high as for silicon carbide. The other properties of bonded fused alumina refractories, with the exception of resistance to spalling, make it a desirable material for use in enameling furnaces. The problem of resistance to spalling can be taken care of in the operation of the furnace by avoiding rapid fluctuations in temperature and by keeping the temperature, after the furnace is in operation, above a red heat at all times.

There are places where silicon carbide is the proper refractory to use in spite of its tendency to oxidize at low temperatures. At temperatures above approximately 2,000 F., the progressive oxidation of bonded silicon carbide refractories is not serious because at about that temperature a glaze coating is formed which protects the refractory from further oxidation.

A few hints are given which the user of refractory products should keep in mind if the best service is to be obtained from those materials.

1. Take plenty of time to dry out a new installation and bring it up to operating temperature.

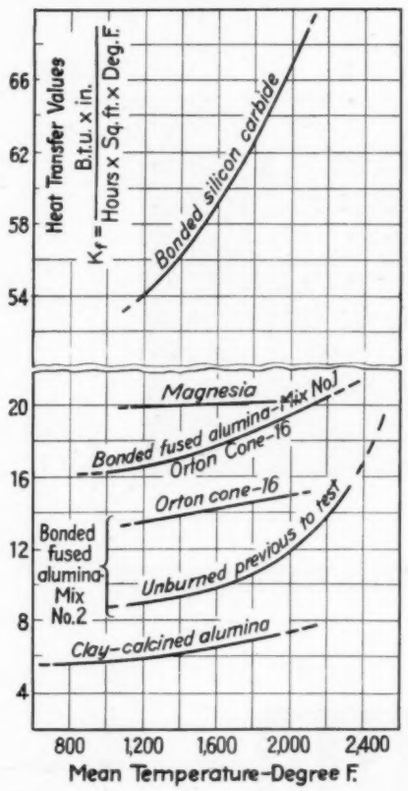
2. Do not overheat the furnace. The refractories used in the construction of the furnace were intended for a given maximum temperature. Higher temperatures may fuse the refractories.

3. Do not use fluxes in contact with the refractory at a temperature where that flux will react with the particular kind of material.

4. When the burners are shut off at the end of the operating period, all openings should be closed and the refractory structure permitted to cool as slowly as possible.

Finally it must be kept in mind that quite generally no one single refractory will fulfill all requirements of use, consequently in selecting a refractory it is usually necessary to compromise on some of the above properties.

HEAT TRANSFER CURVES FOR SPECIAL REFRACTORY MATERIALS



From private report by Prof. Gordon B. Wilkes, Massachusetts Institute of Technology, Cambridge, Mass.

RELATIVE FACTORS FOR DETERMINING USEFULNESS OF SOME REFRACTORY PRODUCTS

Commercially Available Refractory Products	Refractories	Load Bearing Characteristics at High Temperature	Spalling Resistance	Heat Transfer Characteristics	Resistance to Oxidation	Resistance to Reducing Atmospheres	Resistance to Metallic Oxides
Silicon Carbide	*B*	*A*	*A*	*A*	*C**	*A*	*D*
Alumina							
Fused Alumina	*B*	*B*	*D*	*B*	*A*	*A*	*B*
Corundum	*B*	*C*	*C*	*C*	*A*	*A*	*B*
Bauxite	*C*	*C*	*C*	*C*	*A*	*A*	*B*
Diaspore	*C*	*C*	*C*	*C*	*A*	*A*	*B*
Magnesium Compounds							
Elec. Sint. Magnesia	*A*	*D*	*E*	*B*	*A*	*A*	*A*
Calcined Magnesia	*A*	*D*	*E*	*C*	*A*	*A*	*A*
Elec. Sint. MgO-Fused Al_2O_3	*B*	*D*	*C*	*C*	*A*	*A*	*B*
Magnesia Spinels	*B*	*D*	*C*	*C*	*A*	*A*	*B*
Forsterite	*B*	*B*	*C*	*D*	*A*	*A*	*C*
Aluminum Silicates							
Mullite (fused cast)	*B*	*A*	*D*	*C*	*A*	*A*	*C*
Sillimanite	*B*	*B*	*B*	*C*	*A*	*A*	*C*
Andalusite	*b*	*B*	*B*	*C*	*A*	*A*	*C*
Kyanite	*B*	*B*	*B*	*C*	*A*	*A*	*C*
Kaolins	*B*	*B*	*B*	*C*	*A*	*A*	*C*
Fireclay	*C*	*D*	*B*	*D*	*A*	*A*	*C*
Chromites	*B*	*D*	*E*	*C*	*A*	*D*	*A*
Silica	*B*	*A*	*E*	*D*	*A*	*A*	*E*
Graphite	*A*	*A*	*A*	*A*	*E*	*A*	*E*
Zirconium Oxide	*A*	*B*	*A*	*D*	*A*	*C*	*D*
Zirconium Silicate	*A*	*B*	*A*	*D*	*A*	*C*	*D*

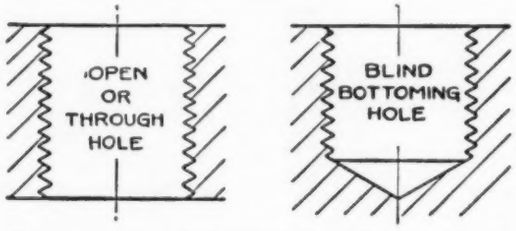
Relative Classification: A — Very high, B — High, C — Medium, D — Low, E — Very low.

* This letter *C* applies to a temperature range of from 1,475 to 2,000 F. At other temperatures a *B* classification applies.

Hole Hints FOR TAPPERS

SLOW production, rejected parts and broken taps, are often due to poor preparation of holes for tapping operations. Here are some points which will help you to prevent costly losses.

Always keep in mind that good clean drilling and a reasonable size maintenance are keys to better, faster tapping and with less strain on the tap and less power consumption.



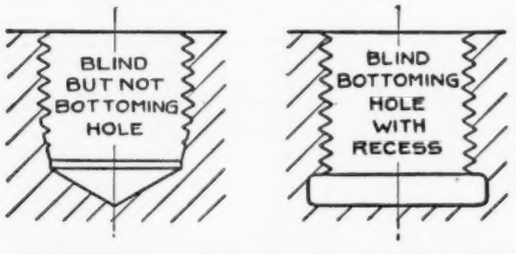
For open or "through" holes in steel, use "*Gun*" or Plug Taps; stick to Plug Taps for gray cast iron and non-malleables; for cast iron containing steel, use "*Gun*" Taps. For blind or bottoming holes, use a Bottoming Tap if the full length of the hole is to be threaded. Always be sure the drill chips are removed from the bottom of the blind hole before you start to tap.

A 100% thread depth requires 3 times the power necessary to tap a 75% thread, but is only 5% stronger. A nut with 50% thread depth will break its bolt before the thread will strip. Good manufacturing practice should provide a depth of thread not less than 62% to 75% (depending on the size) and not more than 83⅓% of the basic thread depth. Remember these facts and you will not make your drilled holes too small.

The tougher and harder the material, or the deeper the tapped hole, the smaller the thread depth you can safely adopt.

Punched holes in thin sheet metal tend to cause taps to "load" and break. See that punched holes are not too small. Same with cored or forged holes in casting or forging. It pays to drill them.

As a guide to the most practicable drill size for all threads, consult any standard tap drill chart. We will gladly send you one on request.



This is one of a series of advertisements published by Greenfield Tap & Die Corporation to help users get greater production from their small tools in these critical times, through making useful facts more widely known

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The Heat Is On

THE HEAT is on in Washington. The White House itself is the center of a new terrific drive to increase defense production quickly. Impatient because results are slow in coming, the President wants the trickle of goods under Lend-Lease to enlarge without delay into a torrent.

This sudden intensification of the Battle of Production is understandable. For one thing, the Russians require help badly and immediately. Britain is in crying need of tanks and bombing planes. Our own forces must have anti-aircraft guns and a hundred other important items. Mr. Roosevelt is trying desperately to put to rout those two generals who have operated so effectively on behalf of the totalitarian powers, Generals Too Little and Too Late.

Unfortunately it is impossible to achieve a production miracle. It just isn't in the cards. But some things can and should be done. If they were done, we'll wager that defense output would be stepped up sharply. Here is a partial list:

1. Hours worked in U. S. industries must be further increased. They already have gone up, but not enough. We can't expect to get the desired results when large segments of industry stick to average work-weeks per employee of considerably under fifty hours.

2. More men must be put on second and third shifts. Hundreds of companies, of course, are on two long shifts or three eight-hour shifts. How many, however, are anywhere near having as many men on either the second or third as on the first shift? Admittedly it is hard to get men for other than the day shift; but it is not impossible. Let's put some steam into the task of finding men for second and third shifts!

3. It's time that labor woke up to its responsibility in this crisis. Strikes and man-hours lost may be fewer now than in 1917-1918; nevertheless the public is fed up with slowdowns and work stoppages on the slightest provocation. For example: A week ago a large steel company suspended operation of seven blast furnaces and forty-seven open-hearths because thirty-nine cranemen failed to report for work. That happened in a key industry tightly pinched by defense demand. Labor leaders should remember that a day lost is a day gone forever. That's why the Army and Navy, up to their ears in the biggest defense job in human history, grow impatient over strikes.

4. Idle machinery should be put to work. Let's not kid ourselves that all the usable machine tools around the country are now active in defense manufacture. They're not. The fact is that in plants throughout the country are thousands of tools not running at all or operated only occasionally. Those possessing such equipment can be of patriotic service by selling it through dealers to defense contractors who can use it immediately. The Tool Section of OPM can be of help in this work.

5. The government itself can aid immeasurably by shortening the time between announcement of a program and the actual placing of orders. The bomber program is an outstanding case. It was initiated at the beginning of June, but weeks went by before contract awards were made to start the tooling. In fact, some of the work is still in the process of being awarded.

This list is by no means comprehensive. It merely points to a few things which can be done right away to help speed production.

We must not fail in our defense effort through indifference or incompetence or for any other visible reason. Never do we wish to be put in the position of the young Frenchman, who said mournfully, "I wonder what France would give tonight for another chance?"

Burnham Finney

GAGING BUSINESS

Machine tool orders mount as heat is turned on armament output. Tank schedule doubled. Henderson applies price control on steel jobbers and steel castings. Plane production up again

Whether or not there is time to save the Soviet, Russia's plight is the occasion for new pressure on war production. The tank schedule is to be doubled; big bombers formerly slated for a 500-a-month output are now upped 50 percent. Steel, machine tools and other key industries feel the heat of Administration urgency for more and more output. Prospects are for double and triple shifts, longer hours and consumer belt-tightening. Even then materials shortages may prove a stumbling block that even the dollar drive of Congress cannot hurdle.

Machine Tools—Pressure on the machine tool industry continues. In some sections September demand was 50 percent greater than for August. The increased orders are part of the new intensified drive to boost defense production originating at the White House and directed principally by Harry Hopkins. Machine tool builders are among those who have been under critical analysis by the Cabinet and the top flight defense officials. Price Administrator Leon Henderson is to meet with a group of machine tool builders next week in the first of a series of sessions with manufacturers on price control. Meanwhile the old price schedule on used machine tools has been re-issued.

Aircraft — September production of 1,914 planes surprised everyone by surpassing August's 1,854-plane output. Something over 1,000 of these were combat types.

Output was still some 300 planes, (about 15 percent) behind the schedule set a year ago for September. However, with 12,651 built so far this year, plane output will exceed the 18,000 units estimated in January as the best that could be expected.

August set engine as well as plane production records. In that month about 2,700 engines of combat sizes were turned out, of which some 700 were liquid-cooled; perhaps 500 of these were exported (exclusive of those on exported planes). Some 1,200 smaller engines for trainers and tanks (which use airplane engines) were built, bringing total horsepower output to about 4,500,000. A year ago horsepower output was 1,500,000 and two years ago 500,000. By companies, Pratt & Whitney and Wright Aeronautical were running about even in August, with production of 1,700,000 hp. and 1,780,000 hp. respectively, while Allison produced some 927,000 hp.

Munitions—The White House is urging medium-sized tank production of 2,000 a month by next spring—just double the former schedule. It is planned to bring every suitable machine tool not otherwise occupied on defense into tank production. Critically short machines, such as big boring mills and planers, are to be used where they stand. The prior plan to move them has been dropped.

Steel—While waiting for Congress to act on price control, Price Administrator Leon Henderson announced that he would clamp two more price lids on the steel industry, using the authority already vested in him.

Iron and steel products sold through jobbers, dealers and distributors will be brought under a price ceiling in the near future to halt "profiteering by certain members of the trade."

Secondly, Mr. Henderson announced that maximum prices for carbon and low-alloy steel castings, including railway specialties, will be established at or below current levels. He said that plans for the schedule had been discussed with 60 producers.

OPA announced also that rumors circulating to the effect that an increase was being considered for the iron and steel scrap ceiling are not true.

Farm Equipment — Efforts are being made to get additional priority help for manufacturers of farm machinery. They now can use a B-1 rating in buying materials they need for new machinery and an A-10 rating for repair parts, but these ratings are too low to get them what they need. The Department of Agriculture, which is figuring on enough increase in farm output next year to provide a fourth of Britain's food, is worried about the situation — particularly because the tight labor supply is increasing the need for mechanization of agriculture. OPM is considering granting higher ratings for agricultural machinery.

Shipbuilding — American merchant shipyards are stepping up gradually to a pace that the Maritime Commission believes will, in 1942, equal the submarine and air attack losses of the British in 1941. Peak of Axis successes against ships at sea was in April, May and June. The losses then led the Maritime Commission to predict its program of new construction on an assumption that sinkings would aggregate 6,600,000 tons per year. The American program calls for 6,500,000 tons of new ships for each year of 1942 and 1943. Shipyards are making 25 percent greater progress since May of this year, Admiral Emory S. Land, chairman, Maritime Commission, reported.

On London Docks—*Lease-lend metal products now are arriving on London docks (above). Soon they probably will arrive on Germany's eastern flank in Russian hands, as congressional objections to aid wane. Supplies discussed by British-American missions will include many tools.*

SLOW SWITCH FROM PRIORITIES TO ALLOCATIONS

Manufacturers warned to retain ratings, but change begun in spring is inevitable war-made trend to controlled economy

BY ROBERT COLBORN

WASHINGTON—Don't tear up that priority rating! The impression has got around that a wholesale revision of the priority system is in prospect, wiping out the system as it now stands and substituting something quite different. It isn't. There is a definite trend towards the use of broad industry-wide formulas including blanket ratings and allocations. Donald Nelson, the new priorities director, drew attention to this trend, which is what caused all the excitement, but it is a trend which has been actively underway since last Spring. Under Nelson there has been a definite tightening of procedures and enforcement, but that's another story.

Actually, the changes going on in the priority setup merely reflect the inevitable war-inspired trend towards a planned government-controlled economy. Last year when the armament drive started, the government was buying weapons like any private purchasing agent. It placed orders and left it up to industry to figure out how to deliver. Such shortages as existed were individual isolated bottlenecks, and these had been handled previously by attaching ratings to particular orders.

Consolidate Individual Certificates

Then, as certain industries found themselves working almost entirely on war orders, it was a natural step to reduce paper work by consolidating a mass of individual priority certificates into one "blanket" rating. Such a rating would entitle a particular manufacturer to preference on all his purchases of certain commodities. In the metal-working industries, most priorities are already of this type, with the individual "PB-1" priority certificate reduced to a trouble-shooting function.

Neither of these methods of control depart very far from ordinary ways of doing business. The government, in effect, simply tells industry what things to do first, and private management draws up schedules which will accomplish this.

Allocation Much Different

Very different is the procedure known as allocation, under which the government tells a material producer, on a pound by pound basis, just who to make deliveries to each month. The first allocation order went into effect last March, and by now all the common metals are alloted. In some cases, such as aluminum and pig iron, full output is directly controlled by the government. In others, like zinc and copper, a percentage of monthly output is reserved for allotment.

Allocation obviously means that to a considerable extent the government takes over the functions ordinarily exercised by management. No procedure will be wiped out. But as allocation becomes more important individual priority ratings will become of less and less importance.

Fabricating Industries Next

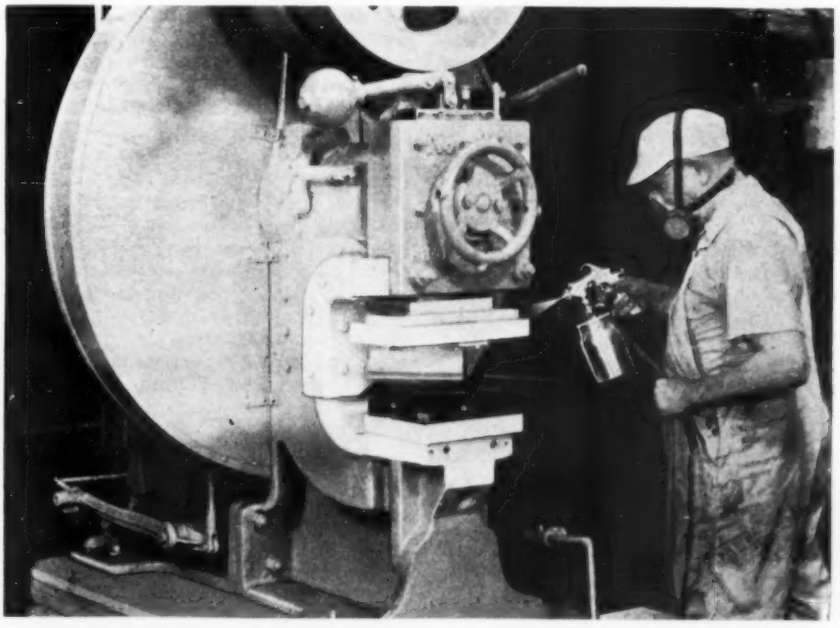
The next big step will be the introduction of allocation into the fabricating as well as the material-producing industries. This would presumably mean that a manufacturer would be told to produce on a certain schedule and would be furnished with the necessary poundages of material to meet that schedule. Something approaching this has already been done in housing, where enough materials were alloted to build 300,000 homes for defense workers, and for the airlines, which were alloted 228 planes instead of being given a priority rating.

When the day comes, as it well may, when the bulk of U. S. production moves on detailed schedules set by the government, the management of industry will find life a lot simpler than it does now when it must fiddle with A-1-d's and PD-3's. It will also find that it has been reduced to about the status of a shop foreman.

CONSOLIDATED WINS NAVY "E"

ROCHESTER—"Nowhere have I seen a more splendid Navy machine shop or gunnery factory," stated Rear Admiral Wat T. Cluverius, U.S.N. retired, when he recently presented the coverted Navy "E" to the Consolidated Machine Tool Corporation. It was the first such award for outstanding naval ordnance production to be given to a machine tool manufacturer, and only the 25th to all industries.

Promising continuation of production efforts, Arthur H. Ingle, company president, accepted the honor, saying "this has been a group accomplishment. And it will continue as such. We are all out for the Navy, all out for democracy, all out for freedom, and all out to win this war." Longtime employees Edward Sayers, D. J. Knapp and Oscar Anderson accepted Navy "E" buttons on behalf of Consolidated's 800 workers.



Safety Through Color—*By spotlighting working areas in light buff enamel and painting the remainder of machinery a medium "horizon" grey, safety in machine tool operations is increased, according to research conducted by Philadelphia Electric Co. and E. I. du Pont de Nemours & Co. Better working conditions, improved labor relations and increased production were also found to result from this "three dimensional seeing" applied above*

Canada Gets Belated Subcontracting Program Under Way; Prime Contractors Still Resist

OTTAWA—Starting from scratch under major handicaps after the war was nearly two years old, Canadian authorities have finally established the framework of a subcontracting or farm-out system which they figure will double production with existing facilities. Canada had been in the war a year and a half when the United States entered it as a non-belligerent through lease-lend but the U. S. is far ahead of Canada in the utilization of industrial capacity through the farm-out system. Canada now is moving fast to catch up.

Reason for Canada's lag in this important generator of war production is inherent. In contrast with the U. S., farming out of parts jobs by major industries was almost unknown. The automotive industry, composed entirely of subsidiaries of U. S. industry, was practically alone in practicing it, and even it depended for a large proportion of its parts and accessories on U. S. plants. Canadian manufacturers of washing machines, refrigerators, radios, electric stoves, other household appliances, secured parts which they did not make mainly from the U. S.

Decide to Supply Equipment

Consequently, when it was decided here and in London that the most important initial contribution this country could make to the Empire war effort was in the supply of equipment, neither Ottawa nor the big industries, recognized the possibilities or the importance of farming out parts of prime contracts.

Less than a year ago, in fact, Munitions and Supply Minister Clarence D. Howe told parliament that regional demands for a share in war work would not be extensively recognized, that war contracts would be mainly placed where large plants and major labor supplies were concentrated. It was not until February, 1941, after men from the automotive and subsidiary industries had been placed in direct charge of war production, that "bits and pieces" was considered at all. Then, through cooperation of Canadian Manufacturers Association and Canadian Chamber of Commerce, a survey of secondary manufacturing and machine shop facilities was undertaken, the results of which have only recently been tabulated and classified.

Agreement Speeded Plan

Coordination of U. S.-Canada aid to Britain under the Hyde Park agreement gave impetus to the subcontracting movement. But it was secondary consideration. Late last spring the pulp and paper industry proposed that the idle time of its service machine shops be utilized on subcontracts. These facilities were then employed only eight hours a day. The government gave indifferent endorsement to the proposal, sent the paper people to its prime contractors who resisted. Prime contractors wanted to hog the work. After getting a few subcontracts the paper industry, setting itself to "go to town" in a demonstration of its capabilities, disposed of the jobs more efficiently, economically and quickly than such work had been done before.

Ottawa saw the light. If idle machine shop time in one industry could be usefully employed, the facilities of other big industries could be used. The mining industry and the public utilities were invited to join in. The oil refining and textile industries are now being mobilized. Mining plants have not done as well at the work as the paper people because they did not appreciate the need for the organization skill of top men.

More Capacity Exists

Even greater unused capacity, however, exists in secondary independent plants across the country. This will be the major factor in the program to double production. Mobilization of this capacity and the distribution of war work through the farm-out system began in July with the appointment of F. L. Jeckell, former executive assistant to Aircraft Production Director-General Ralph Bell, as head of a new Industry and Subcontract Coordination Branch of the Munitions and Supply Department. Prime contracts are being filled in less time because of subcontracting. Plants, which shouted for two years, are getting a chance to contribute to the war effort.

Biggest obstacle is to break down prime contractor resistance with the argument that the war production expansion program and big industries own interests are served by letting small plants do part of the job. One proposal under consideration would insert in prime contracts a provision either to make farming out compulsory or to supply an incentive in the form of contract-price advantage. Authorities still hesitate about going that far.

SAVE ON FIRE TRUCKS

WASHINGTON—To conserve materials, OPM has initiated a move to simplify and standardize fire engine equipment. Thus will end a long time competition between communities for the gaudiest truck. Manufacturers have been asked to drop certain specialized types of equipment such as the new enclosed "sedans", quintuple combinations and salvage trucks. Only three sizes of pumpers, too, are to be built. Bells are to be eliminated. And definite limits have been set on the uses which may be made of critical materials.

PLANES COST $5-$15 PER LB.

DETROIT—Cost per pound of metallic national defense items is 4 to 60 times greater than that of the average automobile, according to D. E. Wilson, president, General Motors Corp. Airplanes and aviation engines cost $5 to $15 a pound, machine guns and ordnance $5 to $10, and battleships and tanks $1. At wholesale, automobiles are priced at an average of less than 25 cents a pound. For simple items such as shell the government pays from 25 to 50 cents.

Army Saves Strategic Metals By Substitution in 300 Items

WASHINGTON — After an early splurge in aluminum and other strategic materials in equipment, the U. S. Army has taken the lead in conservation of scarce metals by substitutions in 300 items. Malleable iron and steel are being used as replacement metal in 96 items of equipment.

Brass and bronze have been eliminated from belt buckles, scabbard snaps, nuts, bolts and electric fixtures. Wood vitrified clay, cast and galvanized iron, steel and glass take the place of nickel. Special finishes make them suitable for table tops, fixtures, steam kettles and 50 other items.

Zinc has been saved in another 50 pieces of equipment by new galvanizing and finishing on pipe, tubing, cables and poles, among others. Quantities of this metal, also, have been saved by elimination in brass and bronze. Use of iron and corrosive resisting steel in such supplies as cooking utensils and laundry equipment conserves aluminum. Wire is being wrapped with porcelain, glass, black iron and lead to save copper.

Refrigerator Production Cut By OPM; No Aid on Materials

WASHINGTON—Household refrigerator manufacturers have been ordered by OPM to cut production during the last five months of 1941 to 43.2 percent below average rate during the year ending July 30, 1941. If this same policy is extended over the following seven months, as is now expected, it will result in production of 2,007,000 units compared with 3,670,000 in the year ending July 31.

No aid is given manufacturers in getting materials to manufacture quotas, so it may be that actual reduction will be even greater.

The cut, as in autos, has been graduated according to size of firm. Those companies making more than 16,000 units a month in the past year are to cut output 45 percent, but in no case will they be asked to produce less than 50,400 units in the five months.

Questioned Steel Expansion Recommended By SPAB Covers Alloys, Plates; Aids Coast

WASHINGTON—On October 1 the Supply Priorities and Allocations Board recommended a 10,000,000-ton addition to the nation's existing 89,000,000-ton steel capacity. Next day the Office of Production Management began the preparation of requests to federal lending agencies, including RFC, for funds to carry out specific projects. It is estimated that the cost of the additional 10,000,000 ton capacity will be about $1,250,000,000.

SPAB's recommendation was based on a report submitted to OPM by W. A. Hauck, steel consultant to OPM, formerly vice-president of Lukens Steel Company. Mr. Hauck is regarded in Washington, by both protagonists and antagonists of steel expansion, as a sound authority. This is the third report on steel since defense got under way. Gano Dunn submitted the first advocating no expansion, and the second saying steel plant should be expanded because of defense demands and Lend-Lease.

Plants Start Projects

The steel industry generally has contended that expansion was not necessary. Some plants, however, did institute expansion projects. Following the request of OPM, the manufacturers have submitted expansion projects totaling 13,118,768 tons capacity annually, most of which would require federal financing. Additional proposals will run the total to over 15,000,000 tons. The new 10,000,000 ton program will be allocated among these projects.

Critics of the Hauck expansion say that the recommendation ignores some important problems: (1) there is not enough scrap to make the additional steel; (2) transportation of pig iron from the Lakes to the processing regions has not been provided for; (3) production would not start for two years; and (4) expansion would consume steel, more urgently needed now than it may be two years hence.

Hauck's report says that 1.3% of present production will have to be set aside during the two years, for use in building the new capacity. This of course will have to come out of allowances for civilian use; no reductions will be made in defense requirements.

Three million tons of the 10,000,000 recommended had already been approved by OPM—before SPAB came into the picture. An additional 5,500,000 tons are needed, the report says, to meet shortages now existing, and to make the West Coast largely independent of Eastern steel plants. Major new requirement on the Coast is due to shipbuilding expansion. The balance of 1,500,000 tons has not been assigned.

Specify Shortages

Specific shortages mentioned include alloys for aircraft, aircraft engines, tanks and tools; plate for ships, freight cars and boilers; armor plate for tanks, ships, guns mouths, helmets and airplanes; and bessemer steel. Critics deplore the enormous amounts of scrap previously sold to Japan.

Cost can be reduced and earlier production assured, the report says, by expanding facilities in existing plants wherever feasible. It is recognized that this new steel plant will not be self-liquidating. Some of the 10,000,000 tons of new capacity can be completed within nine months, most of it within two years provided highest priority ratings are assigned to all undertakings. A further increase of 5,000,000 tons in capacity, recommended for future consideration, would be difficult to obtain and would take up to three years to complete, the report continued.

TAX AMENDMENTS PASS

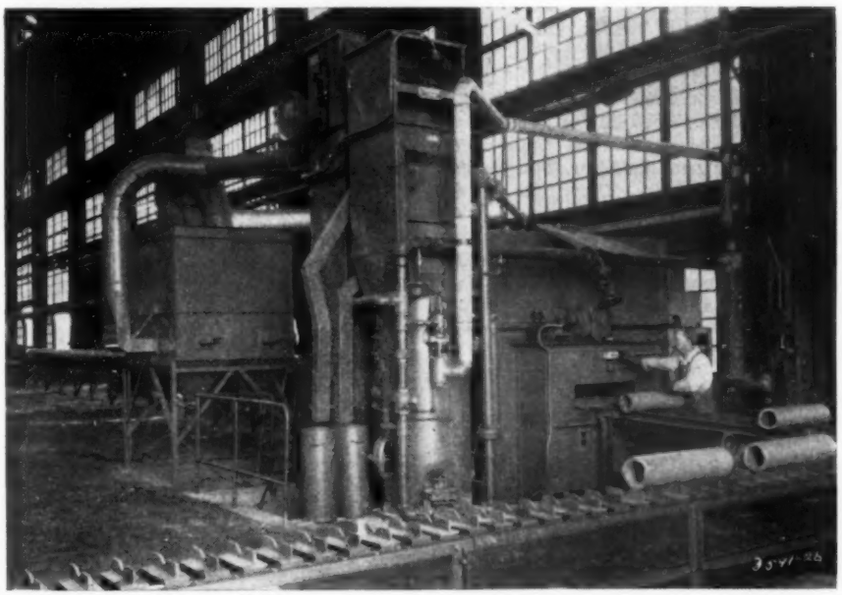
WASHINGTON — Tax amortization amendments (*AM*, Vol. 85, p. 994e) have passed the Senate. They are intended to simplify the conditions under which manufacturers may, for tax purposes, amortize defense-expanded plants in five years. Previously the Senate committee had inserted a new clause giving owners of all plants already started until Dec. 1, 1941, to apply for certificates of non-reimbursement and government protection. Under present law, some plant owners have missed the chance to use the privilege of rapid amortization because they waited too long to apply.

Arming Progress Outlined Before Ordnance Association

DETROIT—Progress made by this country in arming itself and in supplying war goods to Britain and her allies was outlined at the annual meeting of the Army Ordnance Association, October 9. Highlight of the program was a visit to the Chrysler tank arsenal which was in full operation turning out 28-ton (M-3) tanks.

Col. Herbert W. Alden of Detroit was awarded the Frank A. Scott gold medal for meritorious ordnance service. Col. James L. Walsh of New York received the William Crozie gold medal for distinguished service to ordnance. He was the founder and first editor of *Army Ordnance*. Maj. Gen. C. T. Harris, Jr., Chief of Industrial Service, Ordnance Department, U. S. Army, stressed that today the U. S. defense effort is eight or nine months ahead of what it was at the same time during the first World War, nevertheless there should be no feeling of complacency because the task ahead is tremendous.

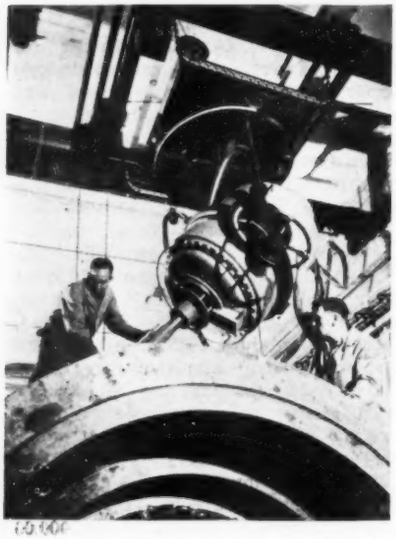
Almost 30 of the 70 specially constructed government ordnance plants are now in full or partial operation, said W. H. Harrison, Director of Production Division of OPM. He remarked that in terms of manufacturing effort the aircraft industry now is at one-third of the maximum contemplated monthly rate. Alvar MacAuley, president, Automobile Manufacturers Association, commented that the motor car industry today has $3,500,000,000 of defense business of which $1,900,000,000 is aircraft and 20 percent is motor military vehicles. American Car & Foundry is now making 400 light tanks a month.



Continuous shell cleaning—*Complete automatic blast cleaning of inside and outside walls of 155 mm. shell in the machine above which was installed in Baldwin Locomotive Works, Philadelphia by Pangborn Corporation, Hagerstown, Md. Shell are fed from conveyor and ejected clean.*

Million-Volt X-Ray Units Discussed at G. E. Symposium

SCHENECTADY—More than 50 trade and business paper editors, representatives of the U. S. Navy and of several industrial plants met with General Electric Company engineers last week for a discussion of present and possible future applications of million-volt X-ray units in industrial plants. Babcock and Wilcox, Combustion Engineering, Ford Motor and General Electric all have these high-power equipments in use for inspecting castings, thick welds and other items. Additional million-volt outfits will soon be in service in other plants and two Navy yards.



Cast and welded parts examined by million-volt X-rays in the General Electric laboratory vary in weight from 40 lb. to 40 tons.

The new portable million-volt industrial X-ray equipment described at the symposium are less than 5 ft. high and 3 ft. in diameter, and weigh only about 1,500 lb. They operate at 2½ times the maximum voltage previously available in industrial equipment. A 5-in. steel plate can be radiographed in about 5 min. at a focal distance of 48 in. with one of these units. With 400,000-volt X-rays, such a plate would require 2¼ hr. at 32 in.

The story of million-volt X-rays, their applications and their possibilities, was jointly told by Dr. E. E. Charlton of the G. E. research laboratory, C. D. Moriarty of the Schenectady works laboratory, O. R. Carpenter of Babcock and Wilcox, A. J. Moses of Combustion Engineering, Donald McCutcheon of Ford Motor Co., and W. S. Kendrick, E. W. Page and G. E. Simons of the General Electric X-Ray Corp. The visitors, also, were shown the works laboratory where X-Ray examination of welds and castings are regular shop procedure.

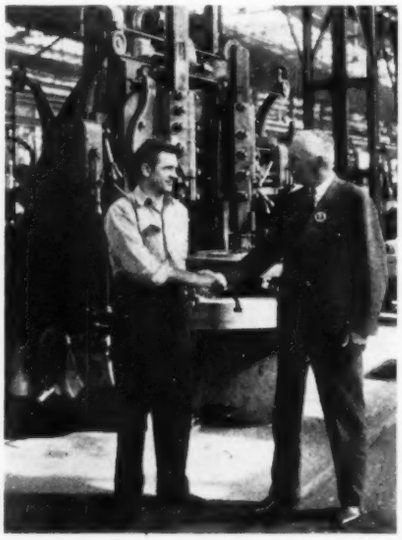
Steel Lack Hinders Canada's Shipbuilding; Strikes Eased

MONTREAL — Canadian shipbuilding, which started out from zero at the start of war and will produce 75 to 85 large merchant vessels this year, is being held back by shortage of steel. Chief source is the U. S. whose own program is taking nearly all the available steel. In some cases $75,000 worth of steel that must be obtained below the border is holding back production of a $1,800,000 Canadian freighter.

For the first time in history it is expected that Canada will build more ships in 1942 than the United Kingdom. Costs are about twice those in Britain but approximately equal those in U. S.

Labor difficulties have been eased, due to the activities of the three man Industrial Disputes Inquiry Commission. Moving more speedily than the Conciliation Board, it has prevented 37 strikes. Coal miners in Nova Scotia have voluntarily given up their slowdown tactics. "Promotions" and other adjustments to raise wages led to settlement of the McKinnon Industries strike before causing production losses at the plants of the parent company, General Motors of Canada. Government prohibition of wage increases was thus circumvented.

Wages and prices are coming under more rigid controls. Wage increases will be prohibited but cost of living bonuses will be enforced in war industries. Retail businesses under license will be policed by regional directors. Raising prices above fixed levels will bring cancellation of license, which is practically padlocking of store.



New Tool Operators—*The 1000th machine tool operator trained in the Baldwin Locomotive Works School at Eddystone, Pa., Edward Thompson is congratulated by C. E. Brinley, president. School opened one year ago this week.*

100 Years of Wire—*W. A. Anderson, president, John A. Roebling's Sons Co., Trenton, N. J., speaking at the Company's 100th anniversary*

Inter-Union Strife Continues; "M. of M." Important Issue

WASHINGTON—AFL and CIO are as far apart as ever and will continue so despite President Roosevelt's appeal to the AFL convention last week. The personal jealousies and basic differences in philosophy still hold forth. Only if and when we get into war will the inter-union row be stopped.

So far labor, along with most everyone else, has taken the national defense program as a big lark. Few if any sacrifices have been made anywhere, in large part probably because none have been asked. Undoubtedly when the time comes labor with the public and management will get steamed up, will make sacrifices.

Meanwhile, a new factor has entered the strike picture—fear that change over from civilian to defense production will mean unemployment. This problem may have been solved by the agreements between UAW and auto companies (see p. 1066g).

Most serious labor problem at the moment is maintenance of membership. Headlined by the National Defense Mediation Board's recommendation in the Federal Shipbuilding case at Kearny, N. J., "m. of m." has been asked by several unions. NDMB undoubtedly would like to recommend it in the United Mine Workers-"Little Steel" case but is held back by the stormy reaction to the Kearny decision. Union pressure may break down the Board's defense.

Final settlement of Kearny situation has not been made, but the Navy holds little hope that the Industrial Union of Marine and Shipbuilding Workers will meet company terms. Two possible solutions are: Navy operation of yard as a Navy shipyard (on Civil Service basis without union recognition) or corporation, possibly formed under RFC operation.

INSIDE DETROIT

Company-union Agreements and interpretation of policies whittle down stumbling block in auto labor relations. Employee morale raised. Training programs, job analyses fill personnel needs

BY RUPERT LEGRAND, DETROIT EDITOR

DETROIT—A major stumbling block to peaceful labor relations during the production phase of the auto industry's national-defense effort has been removed by willingness of individual companies to sign agreements with unions and to interpret the broad policies announced Sept. 17 by the Labor Supply Branch of OPM. These agreements in general will reserve defense jobs to union men according to seniority and broaden seniority coverage. Nevertheless, the step is taken to expedite the defense program by maintaining labor's morale during a difficult period of readjustment.

First agreement was signed by General Motors with the United Automobile Workers (CIO). It was such a masterly statement of policy that the first six points were adopted outright in last week's conference between representatives of other concerns, labor and OPM officials. The seventh point, concerning charges of discrimination in transfers to defense jobs or defense training, will be worked out with the union according to individual preferences. GM will use its ordinary plant grievance procedure, but other members of the automobile and parts industries may set up defense-grievance divisions.

Suspend Seniority Restrictions

The GM agreement was executed because it had become clear that restrictions of seniority which interfered with free movement of men to defense work should be suspended without loss of seniority on non-defense jobs, even though disadvantageous to the employer. In brief, the provisions of the agreement are:

1. Laid-off non-defense workers who take defense jobs elsewhere need not report back for non-defense jobs to retain seniority.

2. Qualified skilled men and semi-skilled men will be transferred to defense jobs upon basis of seniority. Outsiders will be hired only if an insufficient number of qualified men apply. Failing to get a sufficient number of men by either means, employees who apply for and can qualify for training will be accepted on the basis of seniority.

3. New employees will be chosen locally from: (a) qualified men out of work due to civilian curtailment, (b) local non-defense employees who can be spared or loaned, or (c) those facing layoff from prospective curtailment in various industries.

4. Skilled men partially employed or working at other occupations than their trade will be released to defense employers with seniority protection.

5. Above provisions become operative Oct. 2.

6. Laid-off or loaned employees must report back on call for defense work with one week's notice. Defense training is to be considered defense employment, providing that there is an understanding between employer and employee that the latter is being trained for a specific payroll job.

Auto workers definitely will be given defense training if they can qualify. Management is not hamstrung in being required to accept men merely on basis of seniority and not qualifications. Grievance procedure is specified in order to overcome charges of discrimination.

May Loan Men to Others

Within the framework of seniority, personnel managers will be free to ease the readjustment for older employees by loaning men to other companies when layoffs threaten. By continuance of free interchange of information on available qualified men within a community, efficient development of the defense program will be achieved. Moreover, successful handling of the situation may prevent the appearance of "community hiring halls" (AM—Vol. 85, page 994j)

General adoption of agreements paralleling the GM-UAW understanding should do much to restore employee morale, admittedly at a low ebb through fear of widespread and lengthy layoffs under the auto-curtailment program. Results of fear have been: a loss in production efficiency as high as 40 percent, and a refusal to abide by contract provisions regarding layoffs. The Ford Motor Company's threat to layoff 20,000 men brought on slowdown tactics in an attempt to stretch the available work. This will get workers nowhere as companies will not be allowed to carry over unfinished allotments into the next quota period.

Ford Revises Layoffs

The original Ford action was taken one day in advance of a scheduled meeting with union officials to discuss defense layoffs. After that meeting it was announced that instead of 20,000 persons, the immediate layoff would involve 3,000 probationary employees on production and 2,400 non-production employees. Both sides agreed that the balance of the working force can be used for the production quota allowed by OPM through the end of November.

Public agencies and manufacturers are moving on a broad front, often in cooperation, to provide the trained personnel needed on defense tasks. These activities take many forms: in-plant training, retraining and apprentice programs; vocational education to retrain auto workers for defense jobs; job analyses to break down special skills for which there are no applicants, but for which men of related skills can be used; and over-all planning for use of skilled and semi-skilled men laid-off because of curtailment program and for determining what retraining and upgrading are needed.

50 Percent Need Training

A survey of 300 manufacturing plants recently completed discovered that through February layoffs and defense rehiring cancel out in some cases, in others labor shortages will exist, and in some categories a surplus will be found that can be put to work on related occupations in which there is a shortage. A final tabulation of the data, which will be ready shortly, will enable defense manufacturers to locate men being laid off in the community, and will also show up training and retraining needs against a factual background. Probably half the people who will receive defense jobs in the Detroit area will require training of some form.

Prime public source of vocational training for mature persons is the federal supported Defense Vocational

"SPECS" CROSS UP AUTO MEN

WASHINGTON — Aeronautical engineers have sometimes wondered audibly whether automotive plants starting plane production would meet stiff aviation specifications. But some auto production men are complaining that aviation firms don't draw their "specs" tight enough. At one plant now switching over to aircraft accessories, foremen, provided with sets of specifications, were sent on a visit to plant which originally built the product. There they were told by the technicians that, sure, the "specs" say this, but last month we found it's better to make it this other way. Then the man at the bench said that he'd found and was using a different way. Back at the auto plant, however, inspection is based on the "specs," but when the accessories built to the "specs" fail to measure up to the ones from the parent plant, back they come.

Education Program of the Detroit public school system. On Sept. 30, there were 14,287 persons enrolled in 589 classes, as compared with 4,000 individuals on Jan. 1. Altogether, 44,460 persons have received instruction since July, 1940.

Two types of training are provided: pre-employment or refresher classes for selectees from the WPA and state unemployment rolls, and supplementary training offered employed people to upgrade them in an organization or convert them to new tasks, especially those related to defense. These supplementary training programs are frequently worked out with an employer to meet pressing needs on defense, especially sub-contracts. Defense contractors are surveying organizations for past experience of value in forthcoming defense jobs and deciding which workers are most suitable for retraining.

Contributes to Labor Pool

Pre-employment training is currently of declining importance because every facility must be given manufacturers who must retrain organizations. Nevertheless, this phase of the education program has contributed to the Detroit labor pool. Since July 1940, pre-employment instruction has been given to 15,000 persons, including: machine-tool operators, 7,500; draftsmen, 600; bench metal workers, 1300; general welders, 600; aircraft metal-formers, 31, and aircraft riveters, 2,000. Instruction totals 300 hours of class work spread over ten weeks.

Supplementary training has been given employed persons at the rate of four to eight hours per week, but the accelerated defense training plan will calls for six hours weekly. A defense sub-contractor recently asked that 200 people be given 80 hr. of preliminary instruction in aircraft welding, preparatory to finishing the training of these men in his own plant by Jan. 1. For a short time, practically all of the training facilities must be used to aid defense subcontractors in the aircraft field.

The Defense Vocational Education Program trained 3,000 machine-tool operators in the Hudson plant for use in the Naval Arsenal and other Hudson defense projects. At the outset of the Packard program, similar assistance was provided.

Training Program to Save Time

One large prime contractor on aircraft asked local officials to analyze various automobile job classifications which can be transferred to defense production with a minimum amount of on-the-job training. The logical use of this data will be the framing of a training program that will save time. This cooperation is possible because the U. S. Employment Service has been making detailed studies of jobs and workers for six years at least. Volumes of job analyses have been accumulated.

Labor Training and Grievance Handling Discussed at A.M.A. Personnel Conference

PHILADELPHIA—Responsible industrial management in behalf of the basic freedoms we are arming to defend, wise union leadership and sound government labor policy were stressed as three of our greatest needs by Thomas R. Jones, president, American Type Founders, Inc., before the Personnel Conference held Oct. 1-2 by the American Management Association. Mr. Jones' talk on "The Priorities of Industrial Relations" was part of a program including industrial relations problems, handling grievances and expansion of working forces.

No general increases in rate other than those necessary to keep pace with advances in the cost of living should be paid in cash, stated Dr. C. Canby Balderston, Dean, Wharton School of Finances and Commerce, University of Pennsylvania. Such action, he said, is necessary to reduce the pressure of expanded payrolls upon prices. H. W. Anderson, assistant director, personnel staff, General Motors Corp., described the procedure set up by GM for handling grievances.

The mediator's viewpoint was presented by Dr. Egbert H. Van Delden, assistant professor of management and industrial relations, New York University. Dr. Van Delden pointed out that the setting up of machinery for the settlement of grievances was an advantage to the union, to the employer and to the public. A novel pair of talks was given by Helen Dudzik, worker, and George Williamson, president, Williamson Candy Co. Miss Dudzik described some of the conditions she found as a new worker in this organization, and how they were finally corrected through a ways and means committee which had direct contact with the management. Mr. Williamson, in his side of the story, frankly admitted the former defects and expressed satisfaction at the improved arrangements.

English Unions Described

A dinner meeting at the Benjamin Franklin Hotel, Wednesday night, was addressed by C. S. King, director, Industrial and Public Relations, United States Rubber Co. He was followed by W. J. Brown, head of the Assistant Clerks' Association of Great Britain, and former member of Parliament. Mr. Brown told of the present status of union organization in England.

The selection of workers by means of various tests for appraising a worker's aptitude and temperament was described by Guy Arthur, industrial relations manager, R. D. LeTourneau Co. Mr. Arthur stressed particularly the importance of securing the support of the foremen and workers to such tests. D. G. Click, personnel director, Sperry Gyroscope, outlined the methods his company uses in training unskilled workers. He stated that before the workers themselves could be trained it is necessary to train their instructors and to give attention to methods engineering that would break down the job into simpler elements. Upgrading is an important part of this program.

Speaker at A.M.A. Conference

THOMAS R. JONES

Many companies honestly believe they are promoting supervisory training by conducting a series of haphazard conferences, according to C. A. DuBois, training director, Scovill Manufacturing Co. He described an intensive six weeks' training program offered to the local industries of Waterbury, Conn., by the Industrial Foremen's Club. He gave some valuable pointers as to the means of organizing groups and selecting group leaders in order to obtain effective results from such a plan. From the employee's point of view, his increase in ability and his advancement are absolutely essential to his happiness. Further, if an employee feels that there is a better job ahead, he has less hesitancy about breaking in a new man.

A.S.M.E. ELECTS PARKER

NEW YORK—James W. Parker, vice-president and chief engineer, Detroit Edison Co., has been elected president for 1942 by American Society of Mechanical Engineers. Vice-presidents selected for two-year terms were Clarke F. Freeman, vice-president and engineer, Manufacturers Mutual Fire Insurance Co., Providence, R. I.; C. B. Peck, managing editor, *Railway Mechanical Engineers*, New York, N. Y.; W. H. Winterrowd, vice-president, the Baldwin Locomotive Works, Eddystone, Pa.; and W. R. Woolrich, dean, College of Engineering, University of Texas, Austin, Tex.

WATCHING WASHINGTON

Profit limitation not likely until after trial of voluntary wage control. Hillman agreements important factor. Broaden machine tool builder's priority rating. Foundry wage floor established

By BLAINE STUBBLEFIELD

WASHINGTON—Some form of profit limitation on defense contracts will probably emerge from the investigation of defense profits undertaken by Representative Vinson's naval affairs committee, but few observers in Washington see any chance for immediate passage of the drastic profit-limit bill which Vinson introduced this month. Vinson's bill would limit profits to 7 percent of cost on any defense contract—including sub-contracts. Cost is very strictly defined, excluding dues, entertainment, and publicity and advertising expenses among others.

Something like the Vinson bill may however get serious consideration in future months. This bill is not subject to the same disadvantages which have led Henderson and Nelson to reject Morgenthau's suggestion that profits be limited to 6 percent of capital. Morgenthau would set a flat ceiling on the profit of any particular company and thus remove all monetary incentive for increased production; moreover, he neglected to compensate for the wide variation in capitalization in different industries. Vinson, by basing his limit on gross business gets around this. It is possible that any legislation passed will effect all business.

Test Voluntary Wage Control

Most likely occasion for passage of really stiff profit controls next year will be if administration plans for voluntary control of wages break down and it proves necessary to legislate wage ceilings. This would build up irresistable pressure for like limits on profits. Correspondingly, the administration right now will probably frown on really drastic profit limits for fear it would result in wage legislation.

The administration this past week has had to decide how serious it is in its plans for extra-legal control of wages as part of its price policy. Speaking for the President, Leon Henderson has told Congress and the public that he is utterly opposed to writing wage and salary ceilings into law —partly on principle and partly because it just isn't practical politics. His solution is industry-government agreements achieved through extension and strengthening of Sidney Hillman's industry-wide labor stabilization agreements.

This means that, as suggested months ago by *American Machinist*, the stabilization agreements are to become something much more far-reaching than a mere scheme to equalize conditions in different plants, to become in fact a means of wartime labor control. Conceivably, if the war lasts long enough, they could evolve into something like Germany's Labor Front.

Big obstacle to the stabilization agreements is the split in the labor movement. There is no one organization competent to speak for labor. Neither CIO nor AFL can afford to tie itself up in an agreement if its competitor can take this opportunity to move in on it. It is this which has held up the aircraft agreement.

Hillman's solution to this problem is to enforce labor unity on an industry by industry basis. As he says, to deal in each field with the "dominant" union. In this way, he is able to offer to the union selected a substantial quid pro quo for the sacrifices it makes in signing, and he is able to make it safe for a union to sign. Obviously, this policy is bound to raise an explosion from the rejected union.

New Priority for Tool Builders

The limited blanket rating, P-11, giving machine tool builders the right to attach a rating to their purchases of certain materials going into tools (*A.M.*—Vol. 85, p. 726c) expired Sept. 30 and has been replaced by a new order P-11-a. Despite numerous changes in wording, the new order is substantially the same as the original except for additions to the list of purchases to which it may be applied. Paints, lacquers, and finishing materials are now included as well as alloy and carbon steel plates, sheets, and shapes.

Carbon steel bars, forgings and tubes are now included rather than only alloy steel as formerly. All non-ferrous castings are now on the list instead of just aluminum. Machine tool builders, but not their suppliers, may use the rating in buying maintenance and shop supplies. The new order also provides that if a manufacturer or supplier has more than a minimum inventory of a particular item he shall not use the priority rating in buying that item until his inventory is down to minimum levels.

Getting ready to crack down on people who have been misusing priority ratings, OPM has borrowed men from several government agencies which have staffs of field inspectors and will send them out to visit plants and to check what's going on. Wage and hour inspectors, census takers, Treasury procurement officers, and Federal Trade Commission examiners are being used. They will check particularly to find cases where manufacturers have used ratings to buy goods going into non-defense channels to build up inventories.

CRITICIZE SLOWNESS IN DCS

WASHINGTON — Floyd Odlum's reportedly sound job of planning and staffing the defense contract service for spread of defense work has been slow in the eyes of the administration of some senators and congressmen. Pressure from home increases as dislocations come closer. Important results will come soon. But, shutdowns and job losses are inevitable. There just isn't enough work to go around, nor enough material for full capacity of all industry. Odlum faces a showdown soon with army and navy. He should triumph, unless the fighting forces find out how to speed spread of work. Nevertheless they will put up a strong fight before relinquishing one of their voices in defense production.

40 Cent Foundry Wage

A wage-hour industry committee recommendation of a 40 cent minimum wage for the gray iron jobbing foundry industry has been ordered into effect November 3 by Administrator Philip Fleming. Reason for this action is that southern foundries have been paying negro help less than the specified minimum.

Will Investigate Discrimination

Anybody who thinks he's been refused a defense job because of his race, creed, color, or national origin can get his case investigated by writing a letter to the President's Committee on Fair Employment Practice, Washington, setting out the facts. If preliminary investigation indicates that discrimination has taken place, the committee says it will turn on the heat by public hearings, possibly notify other government agencies that the firm is "endangering national unity" (thus presumably blacklisting it), or it will make representations to the President.

U. S. Government Contracts Awarded to Metal-Working Firms

(Does not include contracts under $350,000)

Source	Agency	Commodity	Amount
Servel, Inc., Evansville, Ind	War	Cartridge cases	$561,600
The Ohio Steel Foundry Co., Lima, Ohio	"	Castings	698,625
Harrisburg Steel Corp., Harrisburg, Pa	"	Cylinders	946,500
Sharpsville Steel Fabricators, Inc., Sharpsville, Pa	"	Tan	418,400
Standard Steel Works, North Kansas City, Mo	"	Stand assemblies	459,000
Kilby Steel Co., Anniston, Ala	"	Forgings	6,127,200
Sheffield Steel Corp., Kansas City, Mo	"	"	600,000
Axelson Mfg. Co., St. Louis, Mo	"	"	745,000
Lima Locomotive Works, Inc., Lima, Ohio	"	Locomotive	562,290
Auto-Ord. Corp., Bridgeport, Conn	"	Sub-machine guns	767,112
International Harvester Co., Chicago, Ill	"	Automatic guns	11,913,400
Olds Motor Works, General Motors Corp., Lansing, Mich	"	" "	12,975,000
United Eng. & Foundry Co., Pittsburgh, Pa	"	Howitzers	1,220,199
Chandler-Evans Corp., So. Meriden, Conn	"	Fuel pumps	921,500
Independent Engineering Co., O'Fallon, Ill	"	Oxygen generators	618,000
The Murray Co., Atlanta, Ga	"	Lathes	458,502
Teletype Corp., Chicago, Ill	"	Teletype sets	957,178
Vega Airplane Co., Burbank, Calif	"	Airplanes	26,051,760
Lockheed Aircraft Corp., Burbank, Calif	"	"	30,485,070
Lockheed Aircraft Corp., Burbank, Calif	"	"	62,117,220
Lockheed Aircraft Corp., Burbank, Calif	"	"	2,797,947
Jack & Heintz, Inc., Cleveland, Ohio	"	"	7,833,800
The Cessna Aircraft Co., Wichita, Kansas	"	"	12,043,865
Federal Motor Truck Co., Detroit, Mich	"	Truck tractors	824,670
The Singer Mfg. Co., New York, N. Y	"	Directors	6,864,000
Robertshaw Thermostat Co., Youngwood, Pa	"	Boosters	895,923
Servel, Inc., Evansville, Ind	"	Cartridge case	797,297
Noblitt-Sparks Industries, Inc., Columbus, Ind	"	Chemical bombs	731,921
General Motors Corp., Guide Lamp Div., Anderson, Ind	"	Cartridge case	2,450,000
American Bridge Co., Pittsburgh, Pa	Interior	Steel towers	1,400,378
R.Wallace & Sons Mfg. Co., Wallingford, Conn	War	Cartridge clips	980,400
The Crosley Corp., Cincinnati, Ohio	"	Bomb shackles	729,995
Aluminum Co. of America, Washington, D. C	"	Rivets	431,085
International Harvester Export Co., Chicago, Ill	"	Tractors	507,989
Ralph B. Carter Co., New York, N. Y	"	Pumps	544,300
The Baldwin Locomotive Works, Eddystone, Pa	"	"	757,820
Bowty Equipment Corp., Long Island City, N. Y	"	"	759,200
Caterpillar Tractor Co., Washington, D. C	"	Tractors	371,710
Allis-Chalmers Mfg. Co., Knoxville, Tenn	TVA	Generators	727,812
Teletype Corp., Chicago, Ill	War	Teletype sets	3,013,947
Westinghouse Electric & Mfg. Co., Knoxville, Tenn	TVA	Generators	627,157
Ford Motor Co., Dearborn, Mich	War	Trucks	2,273,395
Bell Aircraft Corp., Buffalo, N. Y	"	Airplanes	75,218,384
Douglas Aircraft Co., Inc., Santa Monica, Calif	"	"	176,316,690
Cambridge Instrument Co., Inc., New York, N. Y	"	Indicators	359,879
Fairchild Aviation Corp., Jamaica, N. Y	"	Camera guns	619,298
Smith & Wesson, Inc., Springfield, Mass	"	Revolvers	1,170,444
Edward G. Budd Mfg. Co., Philadelphia, Pa	"	Shell	1,507,872
The Pittsburgh Water Heater Corp., Pittsburgh, Pa	"	Fuze parts	497,798
Westinghouse Air Brake Co., Wilmerding, Pa	"	Booster parts	544,000
The Hadley Special Tool Co., Inc., Boston, Mass	"	Belt adapters	562,009
Stevens Walden, Inc., Worcester, Mass	"	Cartridge holders	1,033,106
Wagner Elec. Corp., St. Louis, Mo	"	Shot	1,530,000
Gilbert & Barker Mfg. Co., Springfield, Mass	"	Remote controls	598,462
West Tire Setter Co., Rochester, N. Y	"	Sheel banding presses	367,850
Picker X-Ray Corp., New York, N. Y	"	X-Ray unit	535,500
Ford Motor Co., Dearborn, Mich	"	Trucks	1,029,250
Highway Trailer Co., Edgerton, Wis	"	Semi-trailers	553,383
Breeze Corps, Inc., Newark, N. J	"	Tank parts	475,255
Guiberson Diesel Engine Co., Chicago, Ill	"	Tank parts	4,048,209
Campbell, Wyant and Cannon Foundry Co., Muskegon, Mich	"	Carrier tracks	3,094,900
Wagner Electric Corp., St. Louis, Mo	"	Shot	1,530,000
Pittsburgh Water Heater Corp., Pittsburgh, Pa	"	Fuzes	497,798
Hall Scott Motor Car Co., Newark, N. J	"	Engines	465,654
Autocar Co., Ardmore, Pa	"	Tractor trucks	453,900
Yellow Truck & Coach Mfg. Co., Pontiac, Mich	"	Trucks	36,936,055
Douglas Aircraft Co., Inc., Santa Monica, Calif	"	Airplanes, parts	6,061,385
The Lewis Engineering Co., Naugatuck, Conn	"	Thermometer indicators	538,488
General Motors Corp., Delco Remy Division, Anderson, Ind	"	Generators	627,248
Bell Aircraft Corp., Buffalo, N. Y	"	Gun mount adapters	522,632
The Leece-Neville Co., Cleveland, Ohio	"	Generators	1,704,250
General Motors Corp., Allison Division, Indianapolis, Ind	"	Engine parts	2,203,734
General Motors Corp., Allison Division, Indianapolis, Ind	"	" "	4,419,359
Consolidated Aircraft Corp., San Diego, Calif	"	" "	4,003,940
General Motors Corp., Allison Division, Indianapolis, Ind	"	" "	1,573,958
Westinghouse Electric & Mfg. Co., Dayton, Ohio	"	Generators	685,000
General Motors Corp., Delco-Remy Division, Anderson, Ind	"	"	686,825
Vultee Aircraft, Inc., Downey, Calif	"	Airframe spares	1,044,400
Service Tool and Engineering Co., Dayton, Ohio	"	Sight assemblies	383,520
Rome Cable Corp., Rome, N. Y	"	Wire	393,745
Sheffield Corp., Dayton, Ohio	"	Multicheks	455,085
Tube-Turns, Inc., Louisville, Ky	"	Shell	1,970,000
American Thermometer Co., St. Louis, Mo	"	Boosters	980,000
E. G. Budd Mfg. Co., Philadelphia, Pa	"	Bombs	765,860
Dictaphone Corp., Boston, Mass	"	Remote controls	521,994
Waterbury Clock Co., Waterbury, Conn	"	Fuze	2,557,500
Scovill Mfg. Co., Waterbury, Conn	"	"	825,000
Taylor-Wharton Iron & Steel Co., Easton, Pa	"	Shell	826,000
General Motors Corp., Delco Appliance Division, Rochester, N. Y	"	Spare parts	605,000
Niles-Bement-Pond Co., Pratt & Whitney Division, West Hartford, Conn	"	Drilling, reaming, rifling machines	688,900
Charles Engelhard, Inc., Newark, N. J	"	Indicators	360,036
Vultee Aircraft, Inc., Downey, Calif	"	Tanks	490,000
Homelite Corp., Port Chester, N. Y	"	Portable power plants	461,400
Ford Motor Co., Dearborn, Mich	"	Airplanes, parts	231,742,500

NAMES in the NEWS

Stanley Bracken has been promoted from the position of engineer of manufacture to general manager of manufacture, Western Electric Co., New York, N. Y. He joined the company in 1912 as a student engineer in the Hawthorne Works.

Edgar F. Heckert has been advanced from manager, Service Department, York Ice Machinery Corp., York, Pa., to special assistant to the general works manager. Previous to joining the corporation in 1909, he had been an employee of the General Electric Co., and the Southern Utilities Corp.

George J. Hubner has been assigned to the Contract Distribution Div., Office of Production Management, as a tooling consultant. He is publisher of the *Tool and Die Journal*.

Thomas A. Jordan, formerly assistant engineer in charge of design, succeeds F. W. Dencer as assistant engineer, Western Div., American Bridge Co., Chicago, Ill. Mr. Dencer is retiring after 40 years of continuous service with the company.

Herman G. Klemm, executive engineer of the Glenn L. Martin Co., Baltimore, Md., has been named chief engineer of the subsidiary Glenn L. Martin-Nebraska Co., Omaha, Neb. Other appointments to the new company were: Harry M. Shealey, factory superintendent, and Carl B. Hamlin, chief inspector. Mr. Shealey had been assistant factory superintendent in charge of the Canton (Ohio) Div., and Mr. Hamlin was chief inspector at the Middle River, Md., plant.

John Brooks, assistant production manager, AC Spark Plug Div., General Motors Corp., has been loaned to the British Purchasing Commission as an adviser on planning and production.

Wm. F. Lamoreaux, formerly vice-president and general manager, Ducktown Chemical and Iron Co., Isabella, Tenn., has been appointed director of research, Meehanite Metal Corp., Pittsburgh, Pa.

Robert Paxton has been promoted manager, General Electric Company's Philadelphia Works succeeding the late R. V. Good. He had been assistant to Mr. Good and previous to that had been managing engineer of the Panel and Equipment Div.

Louis B. Neumiller has been elected president, Caterpillar Tractor Co., Peoria, Ill. He had been vice-president since 1938. Joining the company in 1915 as a stenographer and blueprint clerk, he held these positions successively: drafting room supervisor, parts

Advanced by York

E. F. HECKERT

Nash Manager

CAMPBELL WOOD

Caterpillar President

L. B. NEUMILLER

Directs Research

W. F. LAMOREAUX

manager, general service manager, sales manager for the Central Division, and director of industrial relations. B. C. Heacock, who had been president since 1930, was elected chairman of the Executive Committee succeeding R. C. Force.

A. M. Ross, former vice-president of Remington-Rand, Inc., Ilion, N. Y., has been elected president of Andover Kent, Inc., Middletown, Conn. He succeeds C. A. Woodruff who recently resigned.

Alex Taub, engineer of Pontiac, Mich., has been designated a special consultant by Associate Director General Sidney Hillman, Office of Production Management. He will assist Mr. Hillman on technical problems involved in the spread of defense work, and the alleviation of unemployment caused by application of priorities. Mr. Taub has worked for the Ford Motor Co., Packard Motor Co., General Motors Corp. and its Chevrolet Div. Since 1936 he had been director of power plant engineering for Vauxhall Motors in England and has served the British government during the war.

G. K. Viall, vice-president, Chain Belt Co., Milwaukee, Wis., has been appointed head of a new division of research and development. He will retain his position as vice-president in charge of the construction machinery division. At the same time, B. F. Devine was promoted from sales manager to manager of the construction machinery division.

Henry C. Wheeler has been elected president-treasurer, Acme Shear Co., Bridgeport, Conn., to succeed his father, the late Dwight C. Wheeler.

Campbell Wood has been named general manager, propeller division and motor parts division, Nash-Kelvinator Corp., Lansing, Mich. His co-executives will be E. F. Keller, and B. E. Ball, factory and production managers, respectively, of both plants. Others who will assist in the operations are B. A. Chapman, plant engineer; D. G. Ellis, purchasing agent; Joseph Slachta, master mechanic; and William Sommer, employment manager. Mr. Keller and Mr. Slachta come from the Nash Motors plant in Kenosha, Wis.

Joseph F. Woogan has been named general manager, United Shoe Machinery Co., Boston, Mass., succeeding the late Harold A. Osborne.

PLANT EXPANSION

Ampco Metal Inc., Milwaukee, Wis. will erect additions to its machine and forge shops at a cost of $250,000.

F. F. Crane, Los Angeles, Calif., is erecting two new machine shops, 20 x 60 ft.

The Defense Plant Corp., a subsidiary of the Reconstruction Finance Corp., has authorized the following lease agreements for plant and machinery expansion:

American Machine and Metals, Inc., New York, N. Y., $240,000.

Bell Aircraft Corp., Buffalo, N. Y., $8,456,175.

The Bullard Co., Bridgeport, Conn., $1,900,000.

Bridgeport Brass Co., Bridgeport, Conn., $820,000.

Curtiss-Wright Corp., Buffalo, N. Y., $978,233.

Salem Mfg. Co., Muncie, Ind., $250,000.

Fafnir Bearing Co., New Britain, Conn., $746,062.

General Motors Corp., Aero Products Div., Detroit, Mich., $11,453,128.

General Motors Corp., Chevrolet Div., Buffalo and Tonawanda, N. Y., $37,161,520.

General Motors Corp., New Departure Div., Detroit, Mich., $2,442,355.

The Parker Appliance Co., Cleveland, Ohio, $432,230.

Reynolds Alloys Co., Lister Hill, Ala., $2,796,079.

Vickers, Inc., Detroit, Mich., $541,721.

Warner & Swasey Co., Cleveland, Ohio, $550,000.

Watson-Stillman Co., Roselle, N. J., $214,451.

Douglas Aircraft Corp., Long Beach, Calif., will add a group of buildings to cost $12,619,096 to its recently completed plant.

Littelfuse, Inc., Chicago, Ill., will begin operations Nov. 1 in a new plant at El Monte, Calif.

Sheldon Machine Co., Inc., has moved into its new manufacturing plant at 4240-58 Knox Ave., Chicago, Ill. The expansion has tripled the company's production of lathes.

Wheelco Instruments Co. has moved into its recently completed plant at Harrison & Peoria Sts., Chicago, Ill.

BUSINESS ITEMS

Kent-Owens Machine Co., Toledo, Ohio, has appointed Eccles and Davies Machinery Co., 1910 Santa Fe Ave., Los Angeles, Calif., agents for power milling machines in the California territory.

Roller-Smith Co., Bethlehem, Pa., has appointed the Electrical Jobber Equipment Co., 501 Fourth Ave., South,

HENRY BUKER DIES AT 68

Henry Buker, vice-president of the Brown & Sharpe Mfg. Co. and continuously identified with that company for 49 years, died Sept. 29 in Providence, R. I. He was 63. For many years he had been one of the outstanding leaders of the machine tool industry. He was a former president of the National Machine Tool Builders Association and had been a member of the industry's Defense Committee since its formation in June, 1940.

Possessed of a keen sense of humor, Mr. Buker had many friends in and out of the machine tool industry. He always had a strong feeling of responsibility to carry any task assigned him. Though he was primarily concerned with the selling end of the Brown & Sharpe business, he was greatly interested in all phases of the operations and particularly in apprentices and the apprentice system. This was in line with his interest in young people.

Mr. Buker was a native of Exeter, N. H., and was educated at Phillips-Exeter Academy. He served a complete apprenticeship at Brown & Sharpe's, at the same time attending classes at Rhode Island School of Design. He spent two years abroad to acquire a speaking knowledge of French and German. Upon his return he took charge of the company's small tool department. In 1917 he became general sales manager and assistant secretary and in 1924 vice president. He also was president and director, Brown & Sharpe of New York, Inc. and Brown & Sharpe Co., selling organizations.

He served as a director as well as president of the National Machine Tool Builders Association. In 1933 he was elected chairman of the NRA Code Authority for the machine tool and forging machinery industries.

Minneapolis, Minn., sales agent for Minnesota, North Dakota, South Dakota, and the western part of Wisconsin.

General Electric Co. has appointed Warren C. Hutchins manager of sales, special products section, industrial department. He succeeds Dr. H. A. Jones.

The Sentry Co., Foxboro, Mass., announces the appointment of Charles R. Pollock, 7450 Melville Ave., Detroit, Mich., as district manager for the Detroit and Toledo areas. As its representative in Florida, the company has named Charles R. Bringman, 310 E. Orlando Ave., Orlando, Fla.

Taylor Instrument Companies, Rochester, N. Y., have promoted Wallace W. Lockwood advertising manager replacing Elmer E. Way.

Vascoloy-Ramet Corp., North Chicago, Ill., has placed R. H. McCormick in charge of advertising and sales promotion. Allan L. Percy, former advertising manager will continue as advertising manager of the parent Fansteel Metallurgical Corp.

OBITUARIES

Paul F. Reichhelm, 68, president, American Swiss File & Tool Co., Elizabethport, N. J., died Oct. 3. He was son of Edward P. Reichhelm, who founded the company in 1900.

Stanley W. Bath, 43, treasurer of John Bath & Co., Inc., Shrewsbury, Mass., died Sept. 22 in Stratford, Conn.

Col. James Brownrigg Dillard, for the past 18 years general superintendent, The Cleveland Twist Drill Co., died of a heart attack on Sept. 28 at his farm in Clifford, Va. He graduated from West Point in 1904, and was an ordnance officer during the first World War.

William LeRoy Emmet, 82, consulting engineer, General Electric Co., Schenectady, N. Y., died Sept. 26 at Erie, Pa. Contributing to many developments in the fields of power generation and ship propulsion, he had been granted 122 patents.

Harry L. DeLisle, 57, president of the Engineering Sales Co., Sheboygan, Wis., was drowned Sept. 27.

John L. Osborne, 61, assistant general superintendent, General Railway Signal Co., died Sept. 20 in Rochester, N. Y.

John A. Farnum, 63, treasurer and general manager, Parker Metal Goods Co., Worcester, Mass., died Sept. 26.

MEETINGS

American Gear Manufacturers Association. Semi-annual meeting. Edgewater Beach Hotel, Chicago, Ill., Oct. 20–22.

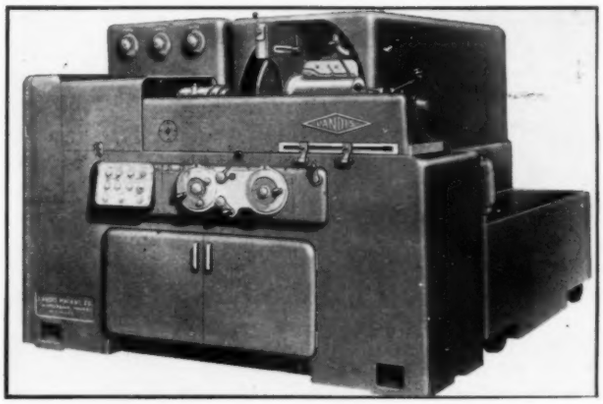
American Society for Metals. Twenty-third National Metal Congress and Exposition. Convention Hall and Commercial Museum, Philadelphia, Pa. Oct. 20-24.

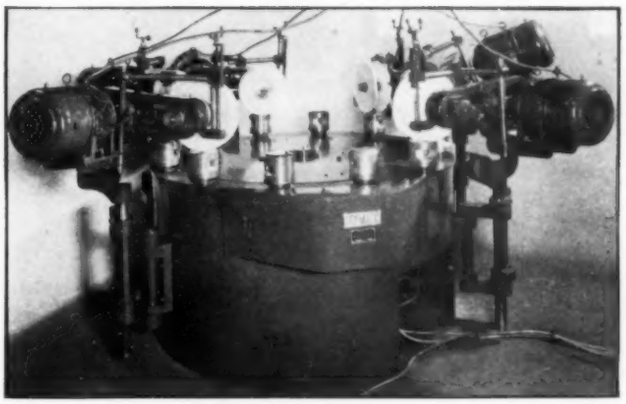
American Society of Tool Engineers. Semi-annual meeting. Royal York Hotel, Toronto, Canada, Oct. 16-18.

American Welding Society. Annual meeting and convention. Bellevue Stratford Hotel, Philadelphia, Pa., Oct. 19-24.

Society of Automotive Engineers. National Aircraft Production meeting. Biltmore Hotel, Los Angeles, Calif., Oct. 30-Nov. 1.

SHOP EQUIPMENT NEWS





Landis Thread Grinder Economical for Jobbing; Work Spindle Nose Takes Standard Chucks

Set up changes on the No. 6 precision thread grinder, developed by Landis Machine Co., Waynesboro, Pa., can be made with such ease and speed that the machine can be economically used for jobbing as well as production threading. The machine is suitable for both right and left hand grinding of 2 to 80 external threads per inch. Maximum diameter is 6 in., thread length on work, 12 in., and center distance, 24 in.

Single or multiple standard, "V", Whitworth, acme, modified buttress and worm threads can be ground on this machine. Maximum helix angle on worm threads is 15 deg. Studs, screws and other parts without centers can be threaded by using a collet chuck. Flanged nose of the work spindle is machined to take standard chucks without using an intermediate flange or adapter. Simplified change gear box permits a large number of English and metric pitches.

Work table, which does not overhang machine base, has its travel limited by trip dogs. Slow and fast speeds are available in both directions. Leadscrew providing positive and accurate feed for table is located centrally between the ways so as to take thrust load without binding or forcing table out of alignment. An automatic device compensates for back-lash. Grinding wheel spindle and bearings are exceptionally large to provide maximum radial support and assure vibration free mounting.

Automatic trueing devices for different forms of threading are interchangeable on the grinding wheel drive unit. This maintains thread size and consistent duplication of accurate smooth finish threads. All rotating shafts and sliding surfaces are completely shielded against dust and grit. All electrical switches, starters, control buttons and rheostats are centralized at the front.

Automatic Buffer Cuts Time Required on Aluminum Pistons

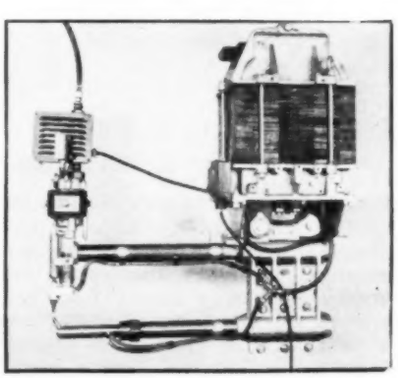
A 97½ per cent time saving in buffing aluminum aircraft pistons has been made with an automatic machine designed by Udylite Corp., 1651 E. Grand Boulevard, Detroit, Mich. Sides and tops of pistons are buffed in 15 seconds compared with 10 minutes by previous hand operated buffing lathes.

Machine consists of automatic indexing table on which twelve chucks to hold pistons are mounted. Six buffing pedals are arranged to accommodate wheels which are driven through a V-belt. Buffing pressure is adjusted by a tension spring and the wheels can be adjusted to any angle. Uniform pressure is thus maintained at all points.

In operation, pistons are loaded on the chucks and indexed automatically to each buffing station. During buffing operation pistons are rotated but are stationary during indexing. One operator is required for loading and unloading. By changing work holding chucks or fixtures and adjusting buffing wheels, other circular parts can be processed.

Welders Mount on Monorails, Ease Many Difficult Operations

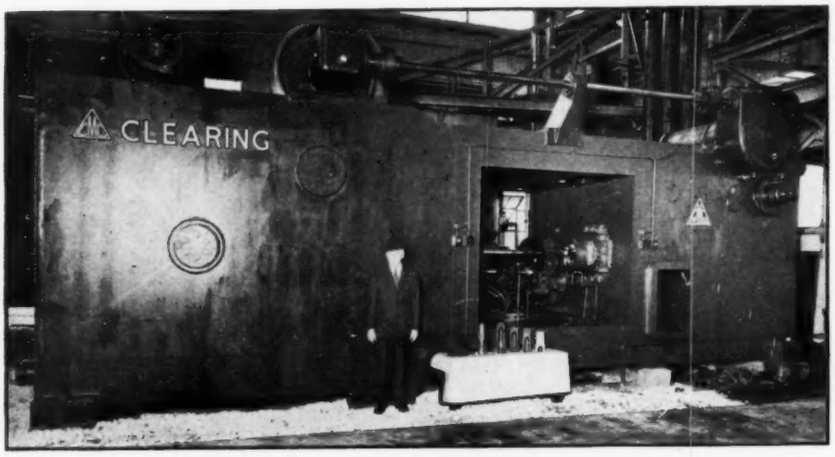
Portable welding machines with built in transformers have been designed by the Progressive Welder Co., 3001 E. Outer Drive, Detroit, Mich., for suspension from monorails and similar mountings. They are a cross between pedestal and gun welders, in that they can be moved to the work and have rigid arms with long throat depth. They have particular advantages for these welding applications: large units needing clearance from floor to arm,



parts on a conveyor, assemblies in several jigs requiring movement of equipment, and spots not easily accessible with other machines due to throat limitations.

Sizes range from 35 to 400 kva., with arm lengths up to 36 in. of throat depth. Arms are adjustable by sliding in or out of support housings. Electrodes are brought together by air pressure operating through guns on the upper arms. Electrode tips are water cooled. Foot controls are connected by flexible cable to control circuit junction box mounted on transformer.

Clearing's Machine Forges Shell Automatically In 4 Operations Without Manual Handling



A completely automatic shell forging machine, which eliminates all manual handling from the time the hot billet is placed in the de-scaler until the finished forging is placed on a coiling conveyor, has been announced by the Clearing Machine Corp., 6499 W. 65th St., Chicago, Ill. It will produce from 240 to 300 finished 90 mm. shell forgings per hour. Less man power is required than on conventional upsetting machines.

Billets are converted into a finished drawn shell in four operations: after descaling, billet is slightly upset to fit firmly in die and piercing is started; piercing is continued and billet changed from square to round form in the second operation; piercing is completed in the next step; and final operation is the drawing of the shell. Each shell is in the machine about 30 seconds.

The three piercings take place without work being removed from the die in the rotary indexing table. Also included on the table are three cooling stations—alternating with the dies. Punches are cooled after each pushing of billet against die.

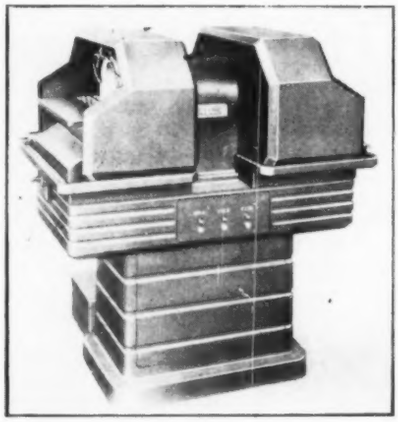
An aligning guide on the first punch strips the work from the punch, and the die table indexes 60 deg., bringing cooling station in front of punch and die with the lightly pierced billet in front of second punch. On the forward stroke of second punch, first is cooled by air and hot water spray. On the return stroke it is coated with colloidal graphite to lubricate it for next punching. A hydraulic guide strips shell from second punch.

After the next indexing, the shell is finished by the third punch, the second punch is cooled in same manner as the first and the first punch pierces a second billet. On the forward stroke the first shell is pushed out of the die into a carrier, also geared to the die table. With the next indexing the shell is swung up in front of drawing unit. A mandrel now enters the shell, forcing it through a set of roller and ring dies which draw it to proper size.

Then, the finished forging is stripped from mandrel and delivered through a chute to a conveyor for cooling. Mandrel is cooled in the following step and sprayed with lubricant. Dies are water cooled.

Ahead of the die loader a descaler can be placed. A special device in this unit scrapes the piercing end of the billet, producing clean metal. This is a protection against scale spots in the shell cavity. Reciprocating motion of punches and mandrel is obtained through large eccentrics, driven from the flywheel through double gearing. A 150 hp. motor drives the flywheel through V-belts.

Lubricant is piped to metering tanks on top of the machine from a 110 gal. reservoir. Venturi passages mix lubricant with air for the sprays. Self-aligning of punches and mandrel hold run out of forgings to close limits.

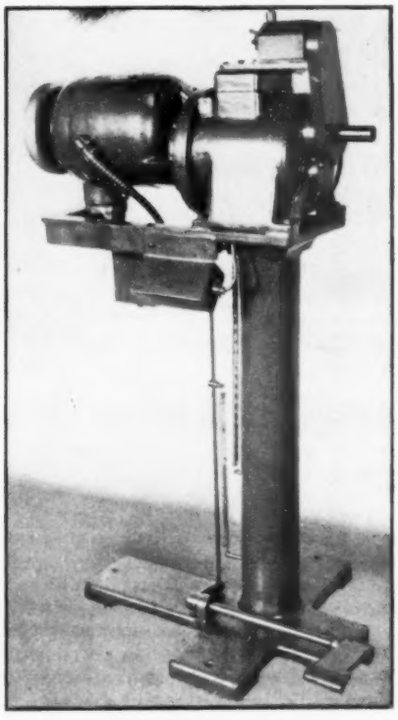


Ex-Cell-O Adds 14 In. Machine To Its Line of Tool Grinders

Ex-Cello-O Corp., 1200 Oakman Boulevard, Detroit, Mich., has added a 14 in. machine to its line of carbide tool grinding machines. This double end grinder can be equipped for either dry or wet grinding. The five previous models in this line of grinders were smaller.

Winder Drives Direct from Shaft Or Through Back Gear System

A coil winder introduced by the Globe & Tool Engineering Co., Dayton, Ohio, drives at high speed directly from the motor shaft, or at low speed through a back gear arrangement. Wire sizes from No. 40 to No. 8 can be wound into coils as large as 8 in. in diameter and 8 in. in length. The counter which



registers up to 10,000 turns can be set to automatically stop on any desired number of turns. Control of brake, motor switch and variable speed is synchronized to a pedal. Thus, simple control of speed through both ranges is obtained. Drive accelerates uniformly from start through an infinite number of steps to top speed, which is 5,000 r.p.m.

Small Parts Cleaned, Plated Automatically in Udylite Barrel

A fully automatic barrel cleaning and plating machine for processing small parts in bulk has been made by Udylite Corp., 1651 E. Grand Boulevard, Detroit, Mich. Parts are progressively subjected to the cleaning, rinsing, pickling, plating and drying operations without manual handling. This automatic transfer saves eight to ten handling operations. Other savings are in material, electric power (only one motor is used), installation (shipped in one unit, machine is ready for connection with water, air and electric supply) and maintenance.

Operator does not stand over tanks, thus is not endangered by fumes and cyanide. Timing is controlled by an electric clock. Machine can be speeded

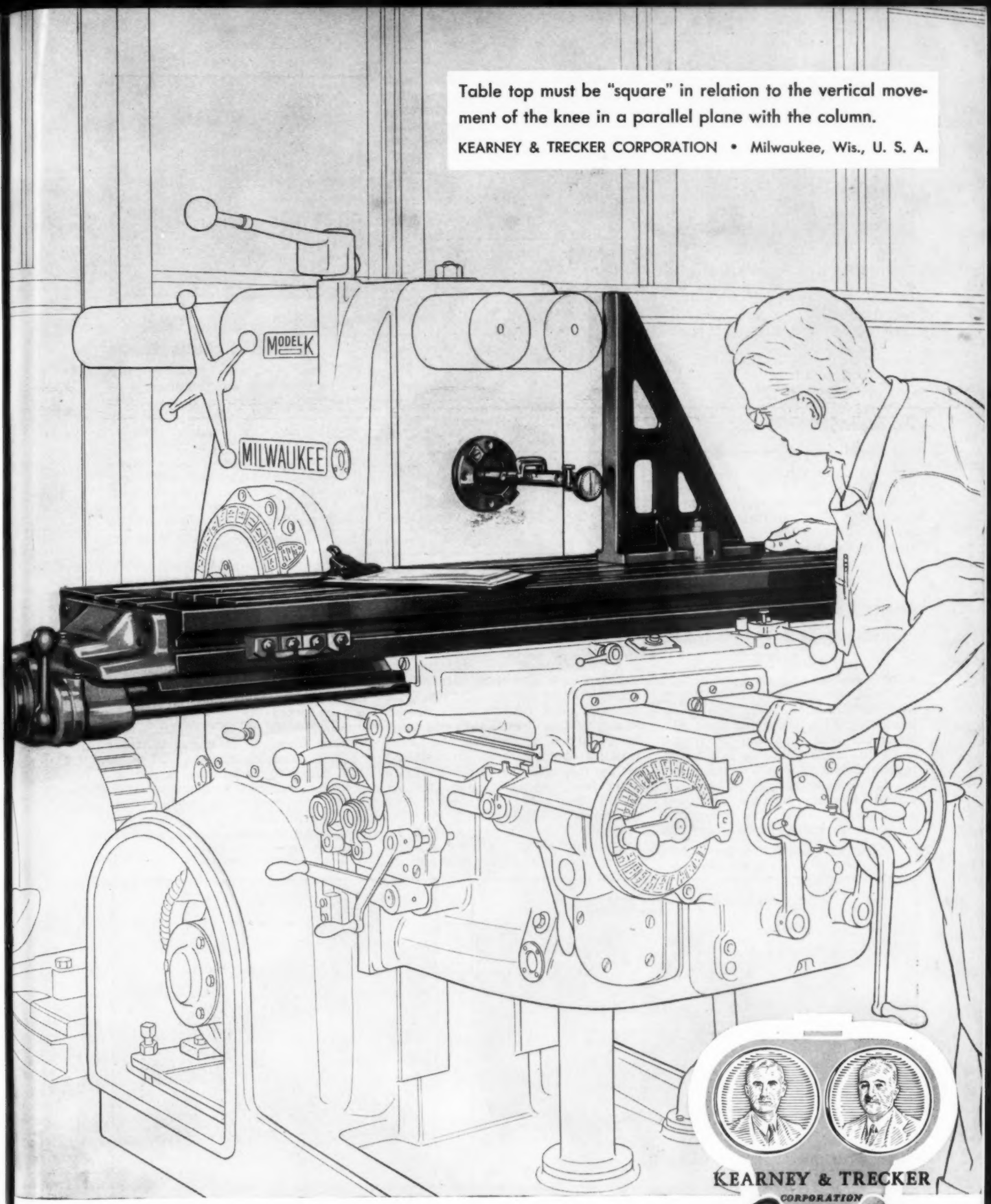


Table top must be "square" in relation to the vertical movement of the knee in a parallel plane with the column.

KEARNEY & TRECKER CORPORATION • Milwaukee, Wis., U. S. A.

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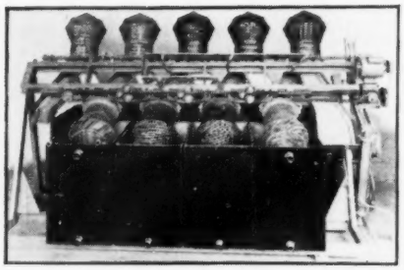
MILLING MACHINES

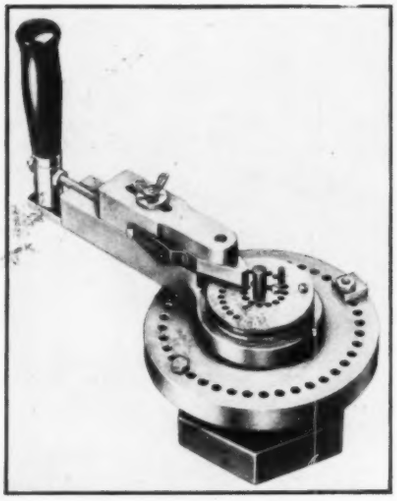
Milwaukee MILLING MACHINES

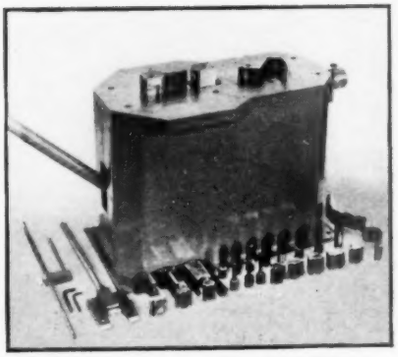


up or slowed only by person authorized to break seal. Timing guarantees uniform treatment for each batch of parts. Many moving parts have been eliminated. These cleaners and platers are being used to zinc plate 20 mm. brass cartridge shell and to zinc and cadmium plate aircraft engine parts.

Die Duplicating Bender Has Right and Left Hand Operation

Two way operation, either right or left hand, of the No. 1 Micro die duplicating bender, manufactured by O'Neil-Irwin Mfg. Co., 316 Eighth Ave., S., Minneapolis, Minn., prevents most material ends from interfering when forming intricate shapes and contours. If interference does develop, operating direction can be reversed. Forming nose is ½ in. high, double that of previous models. An arc welded positive stop is provided for permanently locating nose position. Center mandrel has a large number of holes in an eccentric scroll plate for conversion mountings.





Cold Steel Plate 1-8 in. Thick Bent with Richards Machine

Steel plate 2 in. high and ⅛ in. thick can be bent with the multiform machine made by the J. A. Richards Co., Kalamazoo, Mich. Built particularly for producing dies, it can be used for forming flat stock. An adjustable stop makes it possible to predetermine depth of bend. Circles, as small as the material will permit, can be formed with it. A slight pressure on the lever generates the tremendous power needed at the point of bending. Machine weighs 640 lb.

Automatic Internal Grinder Threads Holes up to 9 1-2 In.

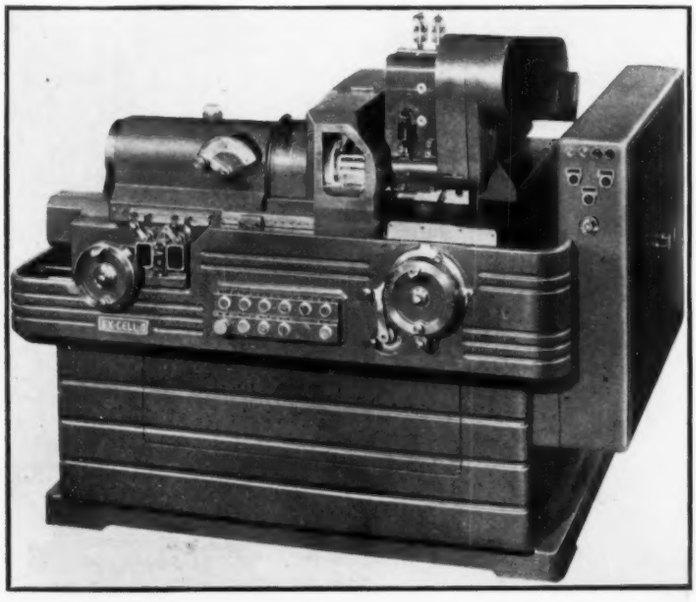
For grinding threads to 5 in. in length within 15½ in. of work spindle nose, Ex-Cell-O Corp., 1200 Oakman Boulevard, Detroit, Mich., has developed an internal grinder, known as Style 39A. Maximum hole that can be ground is 9½ in., while minimum is 1 in. A taper attachment permits grinding to 4 in. in diameter per ft. of effective thread length. Machine operating automatically has a 10 in. swing. It is one of eight standard precision grinders in the Ex-Cell-O line.

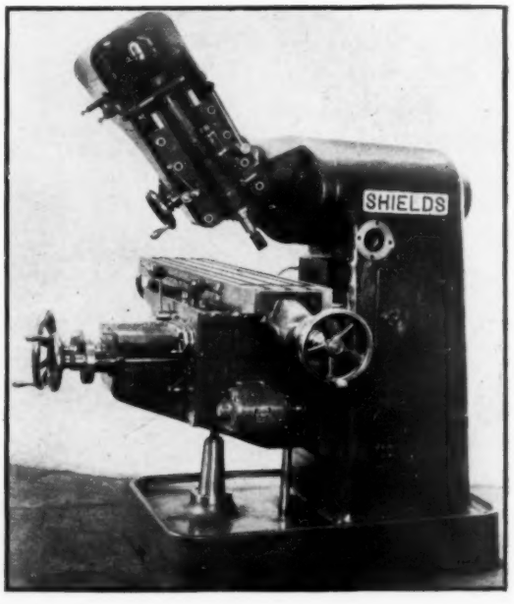
Vertical Miller By Shields Has 8 Speeds to 1630 R.P.M.

End mills from ⅛ to ¾ in. and face mills up to 6 in. can be used on the No. 3 vertical milling machine with universal head, introduced by Shields Mfg. Co. Inc., 38-09 24th St., Long Island City, N. Y. Eight spindle speeds from 72 to 1,630 r.p.m. are obtained for the face mills through helical back gears from the 1,200 r.p.m., 1½ hp. motor. End mills are driven directly through a four step cone.

Spindle slide can be moved 5 in. by a hand wheel. A four position stop is used for step milling or boring. The head can be turned 33 deg. forward or backward from vertical. It also can be swiveled 360 deg. on the column. Scraped flanges make swivels fit snug when locking nuts are loosened. Spindle slide, table saddle and knee can be locked.

Table, which is 12 x 56 in., has a vertical travel of 14 in., cross travel of 12 in. and longitudinal feed of 30 in. Power rapid traverse is 100 in. per minute. Feed is governed by a small hand wheel on saddle. This rate is registered on a 6 in. dial indicator behind wheel. A ¼ hp. coolant pump is mounted in base.

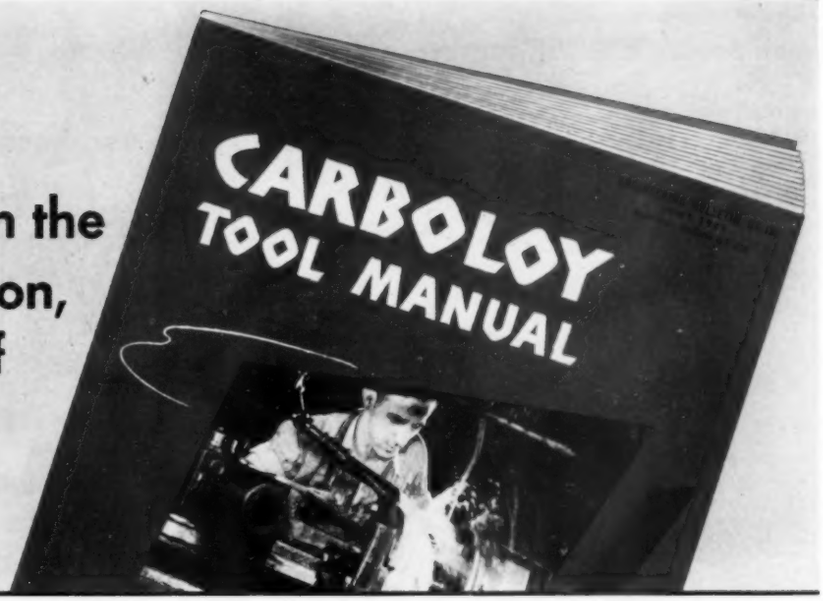




FREE!

To ALL interested in the Design, Application, Maintenance of Carboloy Tools

This NEW 32-page Instruction Booklet.



To assist users and prospective users of Carboloy cemented carbide tools and blanks, we have prepared this 32-page general instruction manual for general distribution.

This booklet contains, under one cover, complete information on the design, application and maintenance of Carboloy tools. Shows how to design Carboloy tools properly, gives correct shank and tip proportions, effective chip breakers, detailed instructions on brazing of Carboloy tips to shanks, rapid grinding procedure, machine requirements, coolants, tool handling systems, etc., etc.

With the vast increase in use of cemented carbides, an increase of such proportions that the *monthly* output of Carboloy Company today exceeds the total production during the entire year of 1938, it is essential that cemented carbide tools now in use be employed in the most effective manner possible. To this end, we believe this booklet will be of unusual value.

To obtain a copy of this new Carboloy tool instruction manual, simply send coupon at right. In the interests of the National Defense Training Program, requests from technical students, apprentices, instructors, etc., will be gladly filled.

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GENERAL OPERATING HINTS

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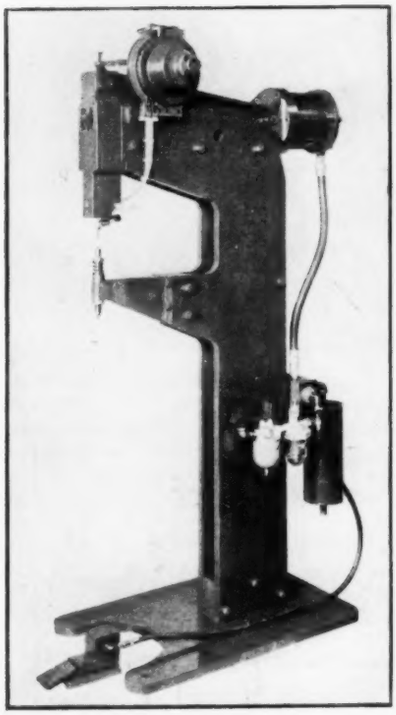
Tomkins-Johnson Adds Rivitor For Use in Aircraft Industry

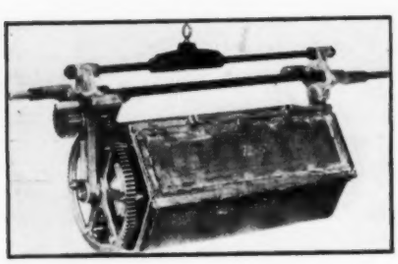
A machine for setting rivets in the aircraft industry has been added to the line of Rivitors made by the Tomkins-Johnson Co., Jackson, Mich. Pressure for setting is furnished by a 6 in. air cylinder operating through a



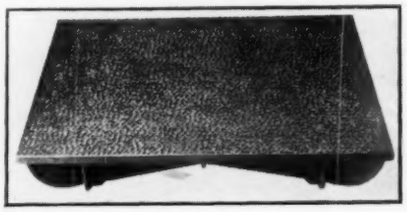
toggle mechanism. The machine sets up aluminum alloy rivets up to ¼ in. diameter and ¾ in. long. Tooling design may limit these sizes. Throat depths available are 9, 12, 14, 16, 18, 20, 22, 24, 28, 30, 32 and 36 in. Ram stroke is 3 in.

Hanson Equipment Processes 600 to 700 Shell at One Time

Cylindrical equipment for processing from 600 to 700 shell at one time is being manufactured by Hanson-Van Winkle-Munning Co., Matawan, N. J. This unit includes rotary cleaning unit with loading compartment. Equipment consists of a double station hot sulphuric acid pickling tank and spray, cold and hot rinse tanks. The first three compartments are lead lined. Lead coils are included in acid and hot rinse tanks. Unloading hopper on



the latter is made of corrosion resistant metal with ½ in. perforations. Exhaust hoods are provided for the sulphuric acid tank. Cylinders, 16x30 in. with ½ in perforations hold 600 to 700 shell of 20 mm. size. Gears and hangars are made of bronze.

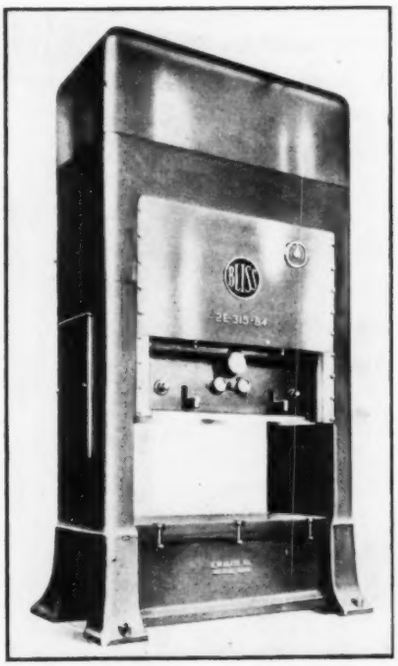


Special Ribbing Prevents Surface Plate Deflection Under Load

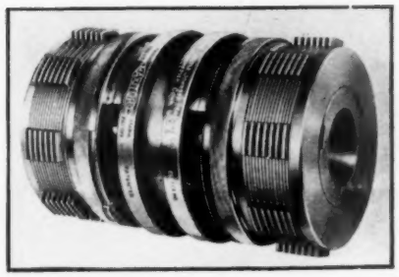
Surface plates with special ribbing to resist deflection and retain accuracy under load are being marketed by Machine Products Corp., Detroit, Mich. Rigidity exists from center to edge of surface and clamping space is provided around entire rim. Special heat treatment relieves casting and machining strains. This prevents distortion after plate has been scraped. Sizes range from 10 x 15 in. to 48 x 96 in. Stands are available for large sizes.

Bliss Press Has 315 Ton Capacity, 84 In. Clearance Between Uprights

A hydraulic press with a capacity of 315 tons has been developed by E. W. Bliss Co., 1420 Hastings St., Toledo, Ohio. This two point enclosed type



press has a hydraulic friction clutch, a hydraulic brake and an air counterbalance. Clearance between uprights is 87 in. Crown, bed, slide and uprights are steel castings.



Johnson Multiple Disk Clutches Come In Dry, Wet Plate Styles

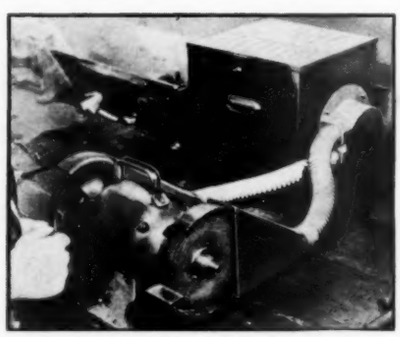
Single and double multiple disk clutches for machine tool and other installations are being put out by Carlyle Johnson Machine Co., 52 Main St., Manchester, Conn. Known as Maxitorq FP, they come in wet plate (all disks of hardened steel to be run in lubricant) and dry plate (alternate disks of steel and self-lubricating bronze) styles. Clutches can be assembled or taken apart without tools.

Adjustments are made manually by turning knurled ring clockwise after raising locking spring. In neutral floating plates or disks do not touch but are separated by springs. Locking plates hold disks against the spring tension. The separator springs assure quick disengaging and prevent excessive drag, abrasion or heat. Non-metallic shoes with studs come with each clutch. Riveted into the engaging lever, they prevent wear in the shipper sleeve groove.

Small, Portable Dust Collector Manufactured by Aget-Detroit

A low cost, compact, portable dust collector has been announced by the Aget-Detroit Mfg. Co., 952 Book Building, Detroit, Mich. Entirely self contained, the Dustkop Model PM100 is suitable for small bench, surface and tool grinders. Air intake capacity of 260 cu.ft. per minute is developed by a ⅛ hp., 110-volt split-phase motor. It has a flexible metal hose with two exhaust intake hoods for quick attachment.

In operation, dust laden air goes through hose into the intake flange. A sirocco type wheel circulates it through a spun glass filter. Dust drops into a pan for periodic disposal. Filters are low cost and easily replaced.



PRODUCTS
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PRODUCTS IN
NATIONAL DEFENSE
Learn how one manufacturer of jewelry cases changed over to ammunition parts
See how hinge butts are made from extruded shapes
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Inspect the model of the new all-metal cabin cruiser, "Revere"
Examine a complete diving suit, gas mask parts, cartridge cases, shell booster assembly, stove unit of an army field kitchen, and other Defense products made with the help of Revere copper and copper alloys.

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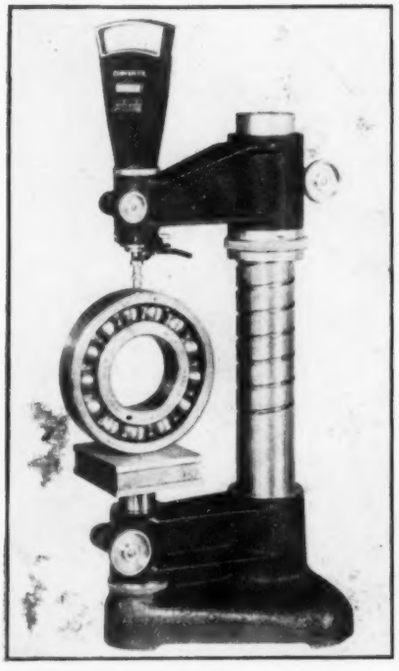
and the unit can be placed in any position and occupies about one sq. ft. of table or floor space. Hose makes a slipfit with hoods and two-way flange.

Inspection of Large Precision Parts Performed on Comparitol

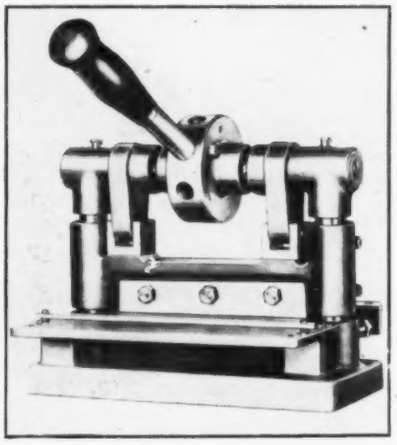
Designed especially to measure and inspect large, heavy, precision work up to 8 in. in diameter, the Model 8 Comparitol, introduced by George Scherr Co., Inc., 128 Lafayette St., New York, N. Y., has scales reading to 0.0001 or to 0.00005 in. It is being used on plug gages, bearings, pins and ball bearings. Unaffected by vibration it can be used under abnormal shop conditions where shock from ma-



chinery or instability of floors prevents the use of standard instruments. A knife edge lever system is used. This model has a 2½ in. diameter column, heavy holder bracket and 4 x 4 in. work table.

Improved Die Duplicating Shear Cuts 24 Gage Steel Plates

O'Neil-Irwin Manufacturing Co., 316 Eighth Ave., S., Minneapolis, Minn., has improved its No. 1 Micro die duplicating shear. Besides heavier castings, it now has a safeguard, material hold-down clamp, and handle-locking arrangement. Overall height has been reduced. Steel plate as thick as 24-gage can be sheared. Blades, ground on both sides, are reversible. For accurately shearing extremely narrow strips, a material length guide, which moves with the shear blade, is provided. A lock bolt permanently locates operating handle



in any one of three positions. Set bolts and 0.002 in. laminated shim stop permits sensitive adjustment of upper and lower blades.

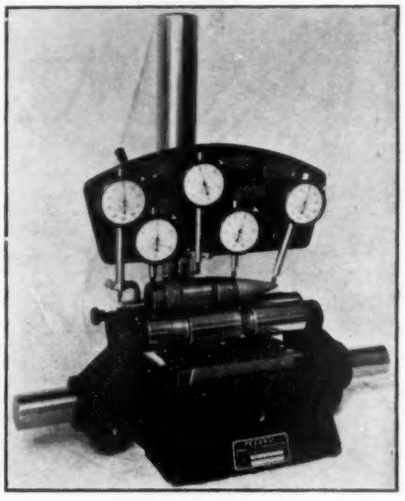
Inexpensive Plastic "I-Gards" Provide Clear, Wide Angle Vision

All-plastic "I-gards" are being manufactured by B. F. McDonald Co., 1248 S. Hope St., Los Angeles, Calif. Injection molded, these industrial eye protectors require no grinding, are inexpensive and strong. Wearer has unrestricted wide angle vision. In

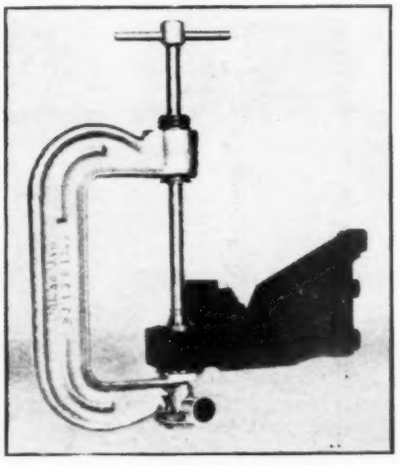
addition to clear lenses, green are available. Pressure on bridge of nose and ears has been done away with. Adequate ventilation improves the nonfogging character of the material.

Mechanical Shell Checker Has No Electric or Air Connections

An entirely mechanical gage for checking shell is being manufactured by Federal Products Corp., 1144 Eddy St., Providence, R. I. It is independent of electrical or air line connections. Shell is cradled in roller V blocks and indicators check diameter and concentricity of fuse hole. It is possible for operator to tell how far out of size imperfect shell may be and to save parts for refinishing. First and upkeep costs are low.



Ground Clamp With Twistite Features Is Spatter Proof



A ground clamp, incorporating the features of the Twistite C clamps, has been introduced by Michigan Clamp Co., Jackson, Mich. This clamp is spatter proof. Swivel foot turns on a ball bearing and will not slip, thus assuring positive ground. Stationary foot is insulated from the frame so that heat of the heavy ampere welding current cannot weaken the frame. A solder lug is provided on the stationary foot for attachment of the ground cable. To clamp, jaw is pushed against work and tightened by handle.

Gage for Setting Boring Bars Obviates Guess Work; Saves Time

A tool setting gage designed primarily for setting the cutter on boring bars has been developed by Bartlet Engineering Co., Beloit, Wis. It eliminates

J&L STEEL

COLD DRAWN BARS

Precision, smooth finish, uniformity are the prime qualities you insist on in cold drawn steel bars. Our first responsibility to all our customers is to maintain these qualities.

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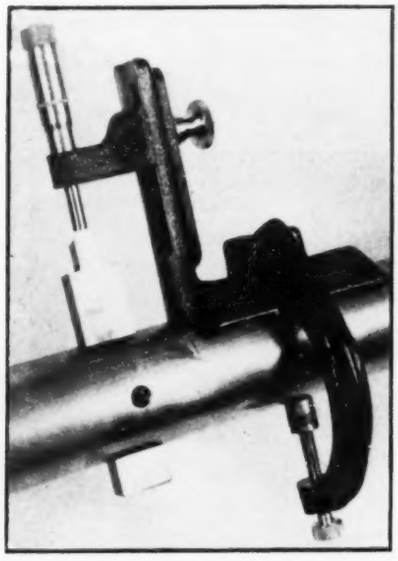
guess work in setting tools not equipped with micrometer instruments. With it the operator saves time, does more accurate work and does not overbore.



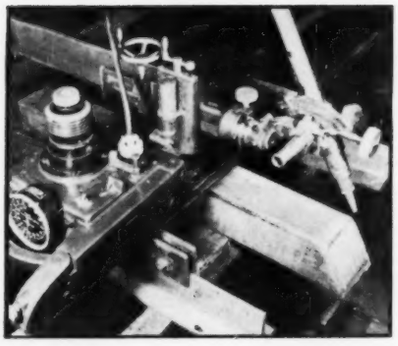
Gage has either a micrometer head or dial indicator. Clamps are supplied to fit bars from 1 to 5 in. in diameter.

Absorbent Sweatband Cuts Time, Increases Worker's Protection

A lightweight absorbent sweatband of synthetic sponge has been announced by American Optical Co., Southbridge, Mass. Sponge is 7½ in. long and exceptionally wide. It keeps sweat out of eyes and off goggles. Besides saving much time formerly lost in mopping glasses and forehead (estimated at 42 minutes per man day in one large foundry), increased comfort and protection is given worker. Band can be sterilized for repeated use.

Torch Holder Improves Angular Cutting; 90 Deg. Range Included

Accuracy and ease of setting cutting torches is increased by the protractor type torch holder recently introduced



by Air Reduction Sales Co., 60 East 42nd St., New York, N. Y. A circular knurled knob permits angular adjustments which register on scale. Holder has a 90 deg. angle and can be attached to standard torches. Time is also saved with the device. Any angle of cut is possible.

NEW MATERIALS

Goodrich's Non-Metallic Material Replaces Aluminum Applications

A non-metallic material, one-third lighter than aluminum and designed to replace that metal in many defense applications, has been announced by the United States Rubber Co., 1230 Sixth Ave., New York, N. Y. Formula C-102 resists ripping, shattering and flowering when pierced by bullets. Free from corrosion, it will not crystallize from vibration. Used as the outside surface of puncture sealing gasoline tanks it gives maximum support to the sealing compounds. One of the possible uses in normal industry may be to replace aluminum panels in bus and truck body construction.

Ameripol Sponge Resists Oil, Grease, Other Deterioration

For applications where oil, grease and other solvents would deteriorate natural rubber, a synthetic sponge rubber has been developed by the B. F. Goodrich Co., Akron, Ohio. Made of Ameripol, it also will stand up under higher temperatures. Sodium bicarbonate or similar blowing agent is turned into gas by the heat of vulcanization to produce the cellular sponge structure.

Motor Mica, Added to Lubricants, Reduces Temperature, Friction

Motor Mica, manufactured by Scientific Lubricants Co., 3462 N. Clark St., Chicago, Ill., will reduce friction and temperature in engine and machinery operations when added to lubricants. Grease and oil consumption, also, is reduced by the compound, which will not cake, harden, slag or gum. Thus more and better work is claimed for a given quantity of lubricant. One oz. of Motor Mica is claimed to go farther than several ounces of graphite.

TRADE PUBLICATIONS

ALUMINUM REFERENCES Aluminum Co. of America, Pittsburgh, Pa., is issuing a series of service bulletins which will give national defense industries latest information from the company's technical departments. First bulletin listed 100 publications of outstanding interest.

BEARINGS IN DEFENSE How The Timken Roller Bearing Co., Canton, Ohio, has aided national defense is described in a 31-page book recently published.

CONE DRIVE GEARING Illustration of applications, description of production, and specifications of cone drive gearing are included in Bulletin CW 41B for executives recently published by Cone Drive Division, Michigan Tool Co., 7171 E. McNichols Road, Detroit, Mich.

CONE DRIVE GEARING Cone Drive Div., Michigan Tool Co., 7171 E. McNichols Rd., Detroit, Mich., has published its catalog No. CW-41A, which gives the design and ratings for cone-drive worm gears. Many applications, including several for machine tools, are included.

ELECTRICAL MACHINERY "Catechism of Electrical Machinery," a 48-page bulletin giving answers to 144 questions on the principles and operation of electrical machinery, has been revised by Fairbanks, Morse & Co., 600 So. Michigan Ave., Chicago, Ill.

HEAT TREATING Ten ways of saving time and labor in heat treating baths are listed in an 8-page booklet published by A. F. Holden Co., New Haven, Conn.

HIGH SPEED PRESS Specifications for two 400 ton flanging and forming presses are listed in Bulletin No. 400 of Beatty Machine & Mfg. Co., Hammond, Ind.

MOTORS The complete line of "Lo-Maintenance" electric motors with ratings from ¾ to 75 hp. are described in an 8-page bulletin No. B6052-B, issued by Allis-Chalmers Mfg. Co., Milwaukee, Wis.

NICKEL STEEL PROPERTIES The International Nickel Co., Inc., 67 Wall St., New York, N. Y., has revised Section II No. 4, "Properties and Applications of Quenched and Tempered Nickel Alloy Steels," of the data book—"Nickel Alloy Steels."

TRANSMISSION BELTS The B. F. Goodrich Co., Akron, Ohio, is circulating its catalog No. 2150, titled "Selection and Maintenance of Rubber Transmission Belts." Information is

given on types, grades, widths, lengths, thicknesses and horsepower capacities of rubber belts for a wide variety of industrial uses. Data are also given on belt dressing, cleaning, storing, static, oil, and salvage, with definite suggestions for maintaining belt records.

UNIT HEATERS Unit heaters, radiators and steam coils are compared in a 36 page catalog published by Ilg Electric Ventilating Co., 2850 N. Crawford Ave., Chicago, Ill. Engineering data, tables, illustrations of proper location of units, and piping diagrams are included.

WELDING ELECTRODES Hobart Brothers Co., Troy, Ohio, have revised their 20 page handbook of welding electrodes and accessories.

WIRE DRAWING Lubricants used in dry and wet drawing of wire are discussed in a 4 page bulletin put out by Magnus Chemical Co., Inc., 252 South Ave., Garwood, N. J.

WIRE ROPE Macwhyte Co., Kenosha, Wis., has issued catalog G-14 listing more than 1,000 wire ropes.

NEW BOOKS

IMPACT RESISTANCE AND TENSILE PROPERTIES OF METALS AT SUBATMOSPHERIC TEMPERATURES—*By H. W. Gillett.* 112 *pages. Published by the American Society for Testing Materials,* 260 *S. Broad St., Philadelphia, Pa.* $2.50.

This volume is the result of two years study by a joint research committee sponsored by the American Society of Mechanical Engineers and the American Society for Testing Materials. The actual work was carried on by a subcommittee headed by Francis B. Foley. The information gathered was referred to Dr. Gillett, at Battelle Memorial Institute, who classified it, added much information from literature and supplied critical comments with the assistance of his associates. A comprehensive bibliography has been added.

The discussion of impact resistance covers limitations, effect of testing variables, impact velocity and cooling technique. Following this there is a section devoted to impact data for non-ferrous materials; an extensive portion of the publication is devoted to a wide range of ferrous materials.

•

BETTER FOREMANSHIP: SECOND EDITION—*By Glenn Gardiner, Forstmann Woolen Company.* 336 *pages. Published by the McGraw-Hill Book Company,* 330 *West* 42 *St., New York, N. Y.* $2.50.

This book is divided into three parts: (1) new features in the relationship between foremen and workers, (2) new ways of handling old foremanship

(Advertisement)

Manufacturers Look to Steel Warehouses for Quick Defense Requirements

Many leading manufacturers are relying on nearby steel-service plants for prompt, stock shipment of steel to meet the current surge of business prompted by Washington's defense program.

Probably the leading exponent of "Immediate Steel" is Ryerson with a net work of ten strategically-located plants each of which has large and complete stocks of steel and allied products. In addition, each plant is equipped with complete forming and cutting facilities so steel can be prepared to customer's exact requirements. No shop should be without the Ryerson Stock List (see advertisement below).

Thousands of manufacturers report saving considerable time, trouble and money by taking advantage of Ryerson's complete flame cutting service. Modern equipment manned by specially trained operators can quickly turn any shape—no matter how intricate—from carbon or alloy steel plates and billets up to 15" thick.

Ryerson Certified Steels Help Build Airacobras

When stepped-up production schedules for these speedy fighter-planes demand quick shipment of uniform, high quality steel, Bell Aircraft Corp. calls Ryerson. Special sheets . . . alloys . . . hot and cold rolled bars . . . strip steel . . . tool steel . . . stainless steel and many other Ryerson products vital to America's Emergency are used by Bell in building the Airacobras.

Stocks at the 10 Ryerson plants are reasonably complete, and service in general is prompt. In times like these, naturally many sizes of certain products are low, some are out. But for the most part, you can depend on Ryerson for good service on thousands of different kinds, shapes and sizes of steel and allied products.

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Rush that job!

Holding up production waiting for it!

Every day is costing us money!

—When customers write and wire like that, it's high time to get a DoAll, today's greatest time saver in metal working plants everywhere.

1/8 FORMER TIME

Connecting Rods for Diesel Engines made in less than 1 hour each at Sumner Iron Works, Everett, Wash. Former time—8 hours each.

1/3 FORMER TIME

Wrist pins for Diesel Engines made from 45 carbon steel in 2 hours, 48 minutes each at Norberg Mfg. Co., Milwaukee, Wis. Former time—8 hours of milling.

DO-ALL Contour Machines
BAND SAWING
BAND FILING
BAND POLISHING

PAYS ITS OWN WAY

This wonder worker in metal saves so much time, effort, temper and material that you can't afford to be without it—not if you use metal or alloys.

Takes the place of shaping, milling and lathe work on hundreds of jobs. Makes special parts, large or small, without dies. Cuts out 40 to 60 shapes at one time by stacking the sheets one above the other.

LET'S GET TOGETHER

We will send a factory trained man to your plant with a DoAll to show you what it can save for you. Just say the word.

FREE — Literature and 158-page Handbook on Contour Machining

CONTINENTAL MACHINES, INC.

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Associated with the DoAll Company, Des Plaines, Ill., Manufacturers of Band Saws and Band Files for DoAll Contour Machines.

functions, and (3) what every foreman should know about today's economic situation. The first portion deals with the foreman's responsibility for maintaining good labor relations, how to handle workers grievances, how to carry out labor policies, and the foreman's relations to wage problems and collective bargaining.

The second part deals specifically with the foreman's job. His problems in cost control of production, elimination of waste, increasing the quality of shop work, elimination of accidents and other means of increasing shop efficiency are discussed. A general treatise on economics, as they affect foremanship duties, is the subject of the last portion of this book.

New industrial conditions, new legislative enactments and new attitudes of labor make the material in this book worth-while reading for foremen interested in advancing themselves and in promoting company interests.

•

GLOSSARY OF METALLOGRAPHIC TERMS—*Compiled by J. Neill Greenwood, professor of metallurgy, University of Melbourne.* 80 *pages. Published by the Chemical Publishing Company,* 234 *King St., Brooklyn, N. Y.* $2.

So fast has the science of metallurgy progressed, that it is small wonder that some confusion exists in the nomenclature employed. This volume is intended to dispel some of the confusion and to serve as a basis for uniformity in terms. It should be remembered, however, that different expressions are commonly employed in different countries, and that some of the terms defined here differ from those most frequently used in the United States. However, the work of Professor Greenwood and others should help to eliminate these differences and to establish a more common scientific language in this field.

The glossary does not confine itself to mere definitions. It attempts to explain the terms and to use cross-references for a more complete understanding of each heading.

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MECHANICS—*By John W. Breneman,* 141 *pages.* $1.50. MATHEMATICS—*By John W. Breneman,* 210 *pages.* $1.75. STRENGTH OF MATERIALS—*By John W. Breneman,* 145 *pages.* $1.50. *Published by McGraw-Hill Book Company,* 330 *W.* 42 *St., New York City.*

These three books have been prepared under the direction of the Division of Engineering Extension of the Pennsylvania State College and are part of an industrial series. Their principal purpose is for use in adult teaching. They serve that purpose admirably. The texts have been thoroughly tested in the industrial training field and in correspondence courses. In fact, they are well adapted for those

who desire to study at home through correspondence instruction.

The text on mechanics is intended for the person who wishes to increase his knowledge of engineering fundamentals. It incorporates the study of simple machines, gears, gear trains, pulleys and mechanisms. It includes the treatment of conditions of equilibrium in static structures, and a discussion on center of gravity and moment of inertia and dynamics.

In the book on mathematics the author gives a brief review of arithmetic, fractions, algebra, including simultaneous and quadratic equations and the use of handbook tables. The fundamentals of plane geometry are covered by the use of geometrical constructions whereby geometrical theorems are made into practical problems. The use of trigonometry is dealt with in a helpful manner and incorporates the fundamental laws solved by both natural and trigonometric functions.

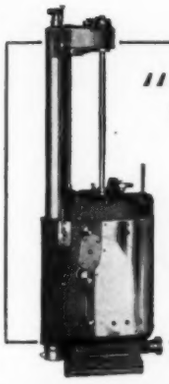
Professor Breneman draws upon the many practical fields of engineering and design in "Strength of Materials." He describes the fundamental principles of both mechanics and strength of materials. The book includes the usual topics of tension and compression. Riveted joints and welded connections are explained. Beam design is thoroughly discussed and beam deflections are considered. The design of steel and timber columns is covered by the latest methods and equations of design.

•

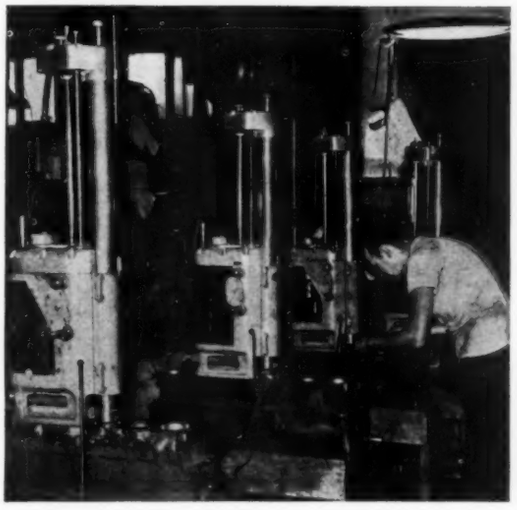
INTERIOR ELECTRIC WIRING AND ESTIMATING—*By Albert Uhl, Arthur L. Nelson and Carl H. Dunlap. Third edition. 354 pages. Published by The American Technical Society, Chicago, Ill.* $2.50.

Since the second edition of this book was published in 1940, the National Board of Fire Underwriters has made important changes in the National Electric Code. The new code gives ratings for 17 different kinds of insulation, where formerly ratings were given only three kinds of insulation for electric wires. The current-carrying capacities of wires using these different insulations, and the different conditions under which each type is to be used, have been included in this third edition. Over 50 pages of new material have been added; in addition all illustrative problems have been revised to comply with the new current-carrying capacities of wires under the different service conditions stipulated. A new section on cable wiring has been written in "how-to-do-it" style. New drawings have been prepared to show the construction of various types of houses and industrial buildings.

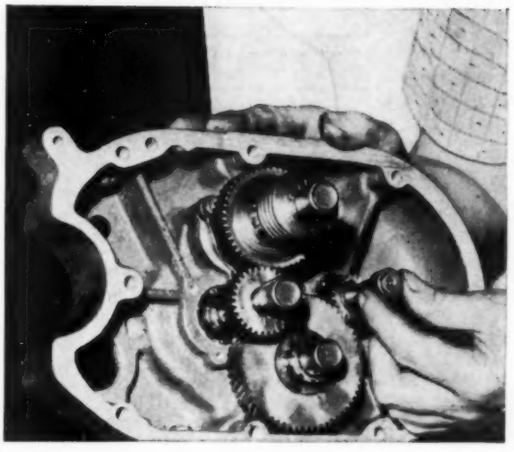
In addition to giving practical information on various methods of wiring new and old buildings, considerable information is incorporated in the book on the estimating of wiring jobs. Detailed instructions are given, showing



"30% DEEPER MACHINING"
WITH COMPACT, ANTI-FRICTION NEEDLE BEARINGS



1. CYLINDER REBORING MACHINES, such as these, do a quick, precise job on auto engines. These advantages are achieved largely through the use of anti-friction Torrington Needle Bearings. Says the maker of this "Stormizing" equipment: "The six anti-friction Needle Bearings occupy no more space than plain bushings, yet they permit the machines to make 30% deeper cuts. And they help assure the even flow of power to cutter needed for high speed precision boring."



2. SMALL, AREN'T THEY, these high-capacity Needle Bearings on the gear shafts! Compact Needle Bearings can be easily adapted to existing housings, giving dependable anti-friction service while keeping surrounding parts small in size and light in weight. Their hardened steel construction and ample lubricant capacity eliminate the need for frequent attention and provide long bearing life. Installation is very simple, and initial costs, too, are low.

Your product, too, may be improved by the unusual features and economies of the Torrington Needle Bearing. Our Engineering Department will gladly assist you in planning for its use. For full information, write for Catalog No. 105. For Needle Bearings to be used in heavier service, write our affiliate, Bantam Bearings Corporation, South Bend, Indiana, for Booklet 104X.

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Makers of Needle and Ball Bearings

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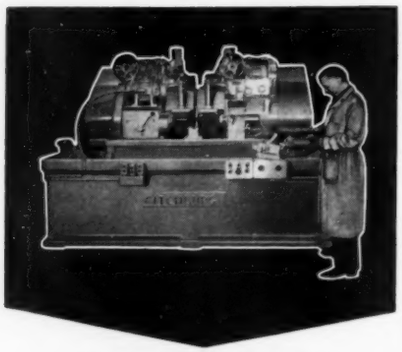
TORRINGTON
NEEDLE BEARING



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result from automatic multiple grinding with special units like that above. On precision grinding these give you savings similar to those you can earn on machined work with multiple tooling and combined cutting.

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offers complete information in new booklet free to executives. Write for it on your business letterhead today. Booklet also explains just why greater accuracy control and complete interchangeability of wheelheads are possible when you standardize on

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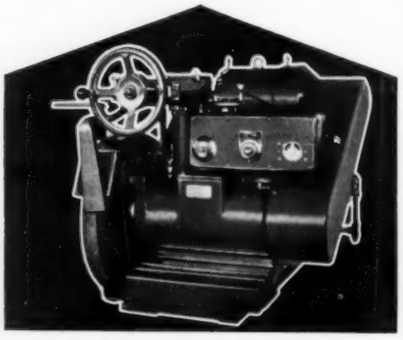

how the electrical contractor would estimate the different electrical quantities and materials needed, so that they can be ordered from electrical jobbers.

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INSPECTION OF METALS—*By Harry B. Pulsifer, Metallurgical Engineer, American Metal Treating Company.* 179 *pages. Published by the American Society for Metals,* 7301 *Euclid Ave., Cleveland, Ohio. Paper cover* $1. *Cloth cover* $1.50. *Add* 25 *cents if foreign postage.*

With metals being put to new uses, particularly in the field of armament, specifications have been tightened, and the necessity for seeing that specifications are observed has become vital. This volume outlines the technique for inspecting metals, and describes the tests that are used for this purpose.

The author assumes that the reader has some knowledge of metalworking practice, and some familiarity with standard test methods. His book is designed to fit a person with this elementary equipment for the status of a responsible inspector.

The emphasis of the book is decidedly on steel. The author starts with "Ideals in Steel Making" and tells how certain obstacles defeat obtaining these ideals. He then discusses in detail virtually all the better known tests for determining composition and physical properties.

SEEN and HEARD

By JOHN R. GODFREY

How Much Scraping?

In spite of greater accuracy in machine construction, the scraper still holds sway in nearly all machine tool shops. In a few shops they simply remove the "fuzz" and "spot" the ways to please the customer's eye. At least one now uses an abrasive brick to do the de-fuzzing, and spots with the aid of a guide for the scraper.

I've also seen a rotary spotting machine where the small, revolving spotter was moved along the bed to overlap and produce a mottled appearance which was pleasing to the eye. The claim that scraping or spotting makes tiny oil pockets seems to be largely washed out by the improved wear secured by Superfinished surfaces, where oil pockets are notoriously absent.

Chrome-Plated Gage Blocks

"After three years of using chrome plated gage blocks, we are more than satisfied with the results." Sounds like an advertising testimonial, but is the statement of the president of a large Detroit tool and die shop. "During the past three years we've used them consistently, every working day, in the grinding department and all other places where gage blocks can be used to advantage.

"On January 14 we subjected this set of gages to a severe test, and one which we would not have considered with steel due to past experience. However, our inspection report indicated a negligible error and shows 90 percent of the blocks within their original tolerance.

"We have also found that the blocks wring together in the same manner as they did before chrome plating and that the plate adheres perfectly to the steel."

Chrome plating seems to have made possible greater usefulness of industry's precious gage blocks, despite the skepticism which greeted their announcement some three years ago.

Chip Disposal

Deciding on modern methods isn't always easy. A friend of mine wants a better way for the disposal of steel chips. He now has a fair sized pile in the shop yard which is hauled away periodically by a local junkman. It's an old concern, and the present junkman's father looked after the chip problem when the shop was started. Mr. Junker, which of course isn't his name, never lets the pile get very big, never needs prodding and his price is satisfactory.

But the scrap pile is unsightly and the super wants to put in a crusher and baler, to put the chips in shape to send direct to the mills. The yard will look better, but the installation will cost real money and involve handling shipping of the bales. Now the junkman looks after all the details. Unless the net return from the baled chips is enough larger than the junkman's price to pay for the baling installation in a reasonable time, it isn't good business to put in the new equipment. It looks as though it might be best to jog along in the old way even if the chip pile isn't a thing of beauty.

Old Man Johnson on Finish and Failures

By JOHN R. GODFREY

Old Man Johnson had just returned from a trip that took in some of the big airports. And was he pepped up about the ships, the shops and the men who run them?

"You remember Godfrey, the finish we used to see on some shafting? Pittsburg finish we called it—*a high polish and a deep scratch.* Don't know how the term ever started. Maybe like the "boiler-makers hair" when old John Runyan checked up on the boiler that was said to be "within a hair," and was three-sixteenths out of line.

"Well, you ought to see how fussy they are with parts that go into air-

planes and airplane engines. Nothing that looks like a scratch gets by for fear that a crack might start from it. The stresses that modern alloyed steels and other metals have to stand, seem to be on the lookout for some innocent looking scratch to start a crack. And when it once starts, there seems to be no stopping it.

"This Magnaflux stunt helps a lot in showing up cracks you never suspect. And they use it plenty. But they use non-magnetic exhaust valves so the flux doesn't work. These valve stems are hollow and filled with a chemical salt to absorb the heat, and unless the hole is dead smooth inside, a crack may get started. Seems sort of foolish to fuss about a hole that only holds salt, but a mighty small tool mark may eventually cause a lot of trouble.

"Speaking of cracks, Godfrey, one of my old railroad friends got a Magnaflux outfit awhile ago and started testing axles, crankpins and other locomotive parts. He found cracks everywhere. Got so he'd dream of cracks. Says he's scared now every time an old loco goes out for fear it will fall apart. He tells me it has made a big difference in the care his men take on finishing parts—so it's beginning to help and he'll get over being scared after awhile.

"I used to think there was a lot of bunk in this extra fine finish Dave Wallace and others were talking about. But if reducing the depth of the fine scratches will cut down the chances of failure in any kind of machinery, I'm for it. We can't afford to buck new things just because we didn't have them in our shop days, Godfrey."

High Speed Rifling

By C. G. WILLIAMS

There is no real reason under the sun why machine gun 0.50 cal. barrels cannot be rifled at a speed of 200 ft. per min. instead of the 60 ft. that you quote (*AM*—Vol. 85, page 709), as carbides cut better at very high speeds than they do at low speeds. We must remember that a cut is only about 0.0005 in. deep.

Broaches can be made to broach the rifling at one stroke of the machine at a speed of 200 ft. per min. if the proper grade of carbide is used. A broach should be good for at least 100 barrels before sharpening and the life of a broach should be around 10,000 barrels.

No reaming operations should be required, or at least not more than one rough ream, if the barrels are to be broached.

The statement that, in a broached barrel, all tool marks are parallel to the helical flight of the bullet is also true of the conventional scrape or hook cutter used to rifle the barrel. Barrel life depends on materials used in the barrel and in the jackets of the bullets and not on the method of rifling the barrel.

Step up production with the

"YANKEE" VISE

The vise of real utility

No. 993 "Yankee" Vise being used as a tapping fixture.

The famous "Yankee" Vise steps up production for any shop which buys it. Consider these time and labor-saving features in the light of your own shop problems:

1. The sides, ends, and base are accurately machined to hold work square on face plate or machine bed.
2. Detachable swivel base permits removal of vise body for continuous, accurate work from bench to machine and back again.
3. Quickly, easily, and economically converted into drilling and tapping jigs.
4. Hardened steel block with V-shaped grooves holds round stock securely. Regular equipment.

The "Yankee" Vise is made in four sizes: No. 991–1½" jaw width; No. 992–2" jaw width; No. 993 –2¾" jaw width; No. 994–4" jaw width. Above vises with detachable swivel base: No. 1991; No. 1992; No. 1993; No. 1994.

Order from your supply house or write North Bros. Mfg. Co., Dept. AM, Phila., Pa., U. S. A.

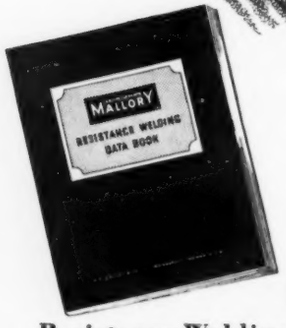
"YANKEE" TOOLS

make *good* mechanics *better*

NORTH BROS. MFG. CO., Phila., U.S.A.

The Executive Engineer Says

"I can appreciate the investment Mallory has made in perfecting their standardization program on welding tips . . . it's the greatest contribution ever made to resistance welding."



MALLORY

Resistance Welding Data Book

Every phase of welding practice, alloys, and specifications is covered by this comprehensive reference. If you do not have a copy, write today.

Mallory's program of standardization of welding tips was not accomplished overnight. It has involved years of the closest cooperation with the leading welding machine manufacturers and it will continue for as long as Mallory makes welding electrodes.

Standardization has resulted in two major and far-reaching advantages. It has made better welding electrodes possible because it has provided unlimited field experience on which to base the specific needs of cooling, hardness, design, thermal and electrical conductivity. Mallory Welding Electrodes give more welds between redressing . . . and a far greater total of welds between replacements. Standardization has likewise eliminated costly delays while waiting for special orders to be completed. Cash in on these twin advantages by specifying Mallory.

P. R. MALLORY & CO., Inc., INDIANAPOLIS, INDIANA *Cable Address* — **PELMALLO**

HELPS KEEP PLANT AT PEAK

PRODUCTION

● BECAUSE production of machine tools has become all important, the following statement of a midwestern manufacturer on his experience with Superla Soluble Oil is doubly significant right now. He says:

"Superla Soluble Oil is helping to keep this plant at peak production by its fine cooling properties and its ability to make fine finishes possible."

As further proof of the adaptability of Superla to many jobs the writer says:

"Machining a clutch gear blank (see illustration) on a Gisholt 1L High Production Turret Lathe with the aid of Superla Soluble Oil is just one of the countless applications in our shops. Every job must be held to close tolerances, and the 10-year experience which we have had with Superla has shown conclusively that its use is a big help in maintaining the accuracy built into these machines, since it will not cause the hardened steel ways to rust or gum up."

For more complete information on how Standard Oil Engineers and Standard Oil products can help *you* get "peak production" see the next page. Then call the nearest Standard Oil (Indiana) office or write 910 So. Michigan Ave., Chicago, Ill., for the Engineer nearest you. In Nebraska write Standard Oil of Nebraska, at Omaha.

Copr. 1941, Standard Oil Company (Indiana)

SUPERLA
SOLUBLE OIL

STANDARD OIL COMPANY (INDIANA)

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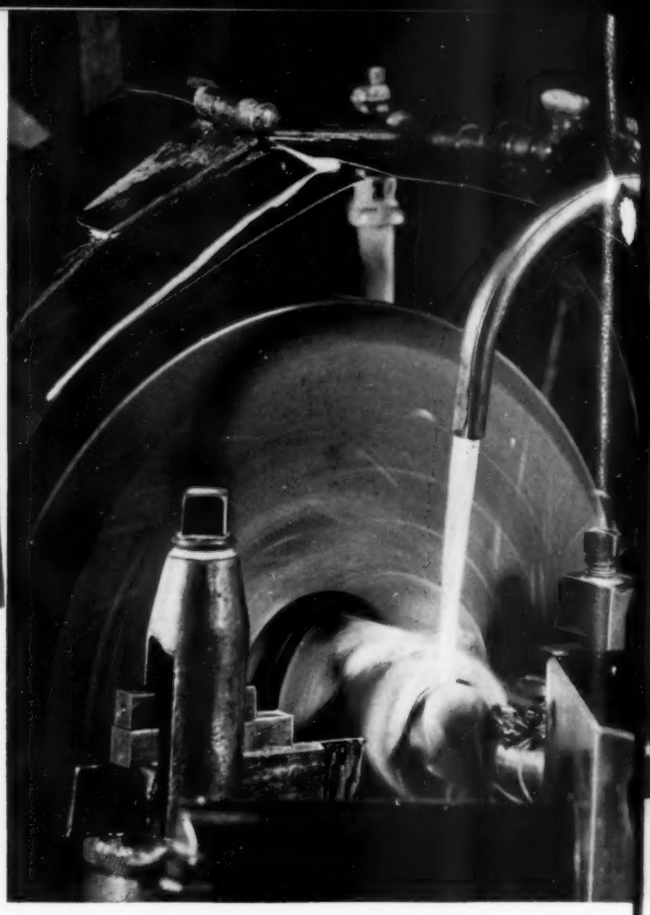
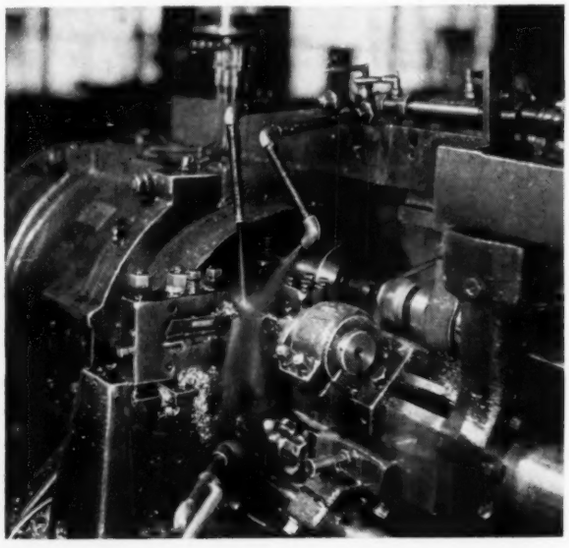
HERE'S ONE WAY TO EASE YOUR TOOL AND MACHINE SHORTAGE PROBLEMS



► ARE YOU FORCED to turn out 1941 production with 1921 equipment—because old machines must be pressed into service—because new type tools are not readily available—and because production needs are climbing steadily? Here's one "straw" that may be a lifesaver. Examine the cutting oils you are using. And let a Standard Oil Engineer help you. The Standard Oil Company has been working on your problem. These Engineers are familiar with the new developments in cutting oils that will make the machines you have, and the tools you can get, as productive as possible. They can call on the complete research and technical facilities of Standard Oil Company for help in solving any special problems you may have.

Start taking advantage of this service right now by calling the nearest Standard Oil Company (Indiana) office listed below. Ask for a Lubrication Engineer.



ACME CUTTING OIL FOR LONG TOOL LIFE

Acme Cutting Oil is a high production oil. It is highly sulfurized. As a result, tools stay sharp and finish is improved. It also means that there are fewer interruptions of production for tool grinding and setting. Acme has made these economies on many types of production jobs in broaching, drilling, hobbing, etc. Why don't you select one job in your shop? Let a Standard Oil Engineer recommend the grade of Acme that he thinks will reduce costs. Then watch what happens.

SUPERLA SOLUBLE OIL SAVES TIME AND TOOLS ...ENDS EMULSION TROUBLE

No time to fool around with stubborn soluble oils? Then it is time to test Superla Soluble Oil. Here are some of the advantages you'll find on the first trial. Superla emulsifies so readily, even in hard water, that no special mixing equipment or softeners are needed. It does not separate and gum machines or oil lines. You'll get longer tool life and better rust protection even with lean mixtures of Superla because the oil stays evenly distributed through the emulsion.

Let a Standard Oil Engineer help you prove these advantages on some operation where you need the extra cooling quality of a soluble oil. He'll analyze the job and recommend the mixture you need. You decide when you see the results he gets.

HERE'S WHERE YOU'LL FIND A STANDARD OIL ENGINEER

If your plant is located in the Middle West you can get the help of one of these Engineers, at Standard Oil's expense, simply by calling the nearest Standard Oil Company (Indiana) office listed below or by writing 910 South Michigan Avenue, Chicago, Illinois. In Nebraska, write Standard Oil Company of Nebraska at Omaha.

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MONTANA
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Green Bay
La Crosse
Milwaukee

WYOMING
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ALLOY BARS a

We'd like to say "YES!"

When a friend needs your help—needs it urgently—you like to say "YES!"

But sometimes, for unavoidable reasons, you are forced to say "NO!"

How you hate to say it!

That's the way we feel today.

Here we are, turning out millions of tons of steel – more than ever before in Republic's history.

Yet, to many of our friends—our customers who have learned to depend upon us for steel—we may have to say "NO" when we'd like to say "YES."

The reason is well known. World affairs demand that we build for defense—defense for your business, your possessions, your home, your family. And modern equipment for defense requires steel—quickly and in unprecedented quantities.

Republic must—*AND WILL*—supply first the steel needed for defense purposes.

At the same time, we want to be fair to *ALL* our other customers in apportioning steel available for non-defense use.

If we have said "NO" to you – or if we must in the future – just remember that we don't want to say it – we'd like to say "YES."

And remember, too, that the steel you can't get is the steel that is being used to protect all of us against an uncertain future.

REPUBLIC STEEL CORPORATION
General Offices: Cleveland, Ohio

Berger Manufacturing Division
Culvert Division
Niles Steel Products Division

Steel and Tubes Division
Union Drawn Steel Division
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TIN PLATE • NUTS • BOLTS • RIVETS • NAILS • PIG IRON
FARM FENCE • WIRE • FABRICATED STEEL PRODUCTS

NO. 7

ALUMINUM, DEFENSE, AND YOU

THE TIMETABLE OF ALUMINUM FOR DEFENSE

up to September 10, 1941

1938 Sept. *Munich.*

Oct. *Czechoslovakia invaded.*

Nov. Alcoa inaugurates $26,000,000 expansion program.

1938

Dec. Alcoa produced 287 million pounds in 1938; had more than a year's supply on hand.

1939 Jan. New extrusion and tube mill begins operation at Lafayette, Ind.

Feb. Start building an excess stock pile of airplane sheet.

Mar. *Bohemia and Moravia occupied.*

Apr. *Albania invaded; Congress authorizes Army to acquire 6,000 planes by July, '41, and Navy 3,000 by '44. Aluminum for all these would take about two months 1941 production.*

Sept. *Poland invaded; U. S. Neutrality proclaimed; limited National emergency proclaimed.*

Alcoa authorizes new metal-producing capacity at Alcoa, Tenn.

Nov. *Finland invaded; Cash-and-carry act signed.*

Alcoa completes $26,000,000 expansion program, begins plans for a larger one.

1939

Dec. *U. S. protests blockade of German exports.*

New metal-producing plant authorized at Vancouver, Wash.

1939 production 327 million pounds; 215 million on hand.

1940 Jan. *First request for defense appropriation in Budget Message.*

Alcoa announces $30,000,000 more plant expansion.

Mar. Alcoa reduces price of aluminum from 20c to 19c, starts construction of Vancouver, Wash., plant.

Apr. *Denmark and Norway invaded.*

May *Low countries invaded; National Defense Advisory Commission named.*

New metal-producing unit begins operation at Alcoa, Tenn.

June *Dunkerque; France capitulates.*

Additional metal-producing unit authorized at Alcoa, Tenn.

July *Congress lifts previous limits on numbers of planes.*

Aug. *Air offensive against England begins; 50 destroyers exchanged for island air bases.*

Alcoa reduces price of aluminum ingot from 19c to 18c; capacity for making alumina increased.

Sept. *Egypt invaded; Selective Service Bill passed.*

First metal manufactured at Vancouver, Wash., plant and new units for additional capacity authorized.

1940

Oct. *Rumania invaded.*

Alcoa authorizes another $150,000,000 for expansion.

Nov. *26 bombers on contract turned over to Britain.*

Alcoa reduces ingot price from 18c to 17c; additional capacity authorized at Badin.

Dec. Alcoa 1940 production 413 million pounds; 154 million on hand.

1941 Jan. *OPM established; NDAC says aluminum supply adequate to meet October, 1940, estimates of requirements.*

Alcoa authorizes additional capacity at Alcoa, Tenn.

Feb. *Aluminum put on priorities.*

Mar. *Lend-lease bill signed.*

Alcoa produces 44,000,000 pounds of metal this month.

Apr. *Yugoslavia invaded; U. S. occupies Greenland.*

May 150 million-pound-annual-capacity plant at Vancouver, Wash., completed and operating at capacity.

June *Crete lost; Russia invaded.*

July *New Government aluminum plants authorized; U. S. occupies Iceland; Japan moves into Indo-China.*

Alcoa produces 53,000,000 pounds this month; Badin unit authorized November, 1940 starts operation.

1941

Aug. *U. S. Government announces Aluminum Company of America will build and operate 3 Government-owned aluminum smelting plants and one for making alumina.*

Alcoa announces ingot price reduction to 15c, effective October 1, 1941.

Alcoa and T. V. A. conclude agreement to unify two great hydro-electric power systems in the Tennessee Valley, which will add at least 200,000,000 pounds to America's annual aluminum producing capacity.

Alcoa produces 54,000,000 pounds of aluminum this month.

Sept. Sites selected for one of the Government-owned aluminum plants and for the alumina plant; railroad, water, and sewage facilities provided; construction contracts being executed.

Excess stock pile of aluminum airplane sheet started in February, 1939, being maintained at 5,000,000 pounds.

ALUMINUM COMPANY OF AMERICA

Let "ELECTRIC TOOL HEADQUARTERS" Help You Get

MORE OUTPUT per man hou

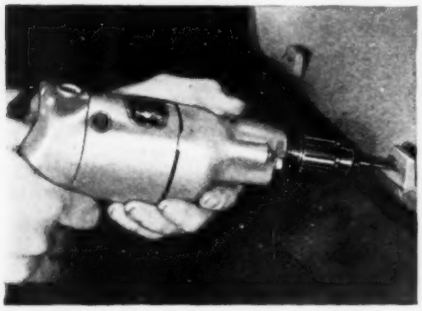
DRILLS—Black & Decker's Electric Drill line contains 30 models of various types and capacities —from tiny 3/16" Drills up to the big 1-1/2" Heavy Duty Drill and Reamer. Above illustration shows Black & Decker 3/4" Utility in operation drilling a tapper pin hole in metal hopper.

Quick Facts for FACTORIES

Here's what Black & Decker offers to help you meet the vital demand for more output per man, per hour, per square foot of working space:

1. Dependable advice on tooling up, through the largest field force in the electric tool industry
2. 120 different types of portable electric tools, a few of which are illustrated here
3. The engineering "know-how" to produce tools specifically designed to solve a definite problem; tools that will last longer, give more service
4. A convenient and informed source of supply, through leading distributors in all principal cities
5. Prompt repair and parts service, through 25 factory-owned service branches from coast to coast

Ask your jobber or write us for complete catalog. Or wire for a factory representative to advise you on tooling up problems. Address: The Black & Decker Mfg. Co., 716 Pennsylvania Ave., Towson, Md.



TAPPERS—Eight times faster than hand, Black & Decker Electric Tappers speed operations on large assemblies and reduce tap breakage. Accurately tap in iron, steel or alloys.

SCREW DRIVERS—Woman operator assembling electric iron with one of the 17 Black & Decker Power Driver models. Capacities — from No. 4 machine screw up to 3/4" lag bolt.

NUT RUNNERS—Black & Decker's 10 Electric Nut Runner models tighten everything from 1/4" nuts up to 1" diameter bolts. Above—bolting flange plate on steel beam.

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Describes the 120 Black & Decker Portable Electric Tools and 1,000 tool Accessories and Attachments.